SIXTEENTH ANNUAL REPORT

of

Pasture Research

in the

Northeastern United States
State College, Pennsylvania

1952

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REPORT

OF THE PASTURE RESEARCH LABORATORY

INTRODUCTION

The Annual Report of Pasture Research for the year 1952 is presented herewith in a form similar to that of preceding reports but with some minor differences. It contains the annual report of the Pasture Research Laboratory at State College and reports of cooperative and State Station projects in the Northeast, in that order. The cooperative report is that of the NE-10 Forage Crop Technical Committee and was prepared by its chairman, Dr. H. R. Albrecht. The reports of the State Station projects were submitted by the respective collaborators, and are here presented as State units, even though some of the projects are cooperative between states and with the Pasture Laboratory. All the reports included here are progress reports and as such may contain statements which may not be verified by subsequent experiments. This report is for administrative use and does not constitute publication. Citations to any particular statement in this Report should not be published without permission from the author. Since this Report is mimeographed in a limited number, it is not available for general distribution.

During the year a number of changes occurred in the Laboratory personnel. Dr. R. J. Garber, Director, left in September on a year's leave of absence to assist in the world-wide program of the Food and Agriculture organization of the United Nations. He is stationed in Rome, Italy. During his absence the Acting Director is Dr. J. T. Sullivan. Dr. A. A. Hanson, Project Leader in charge of cytogenetics, left the Laboratory at the close of the year to head the Grass Project at Beltsville. Miss Ellen L. Poorman, Secretary, resigned in June.

Dr. Howard L. Carnahan, a graduate of Kansas State College and the University of Minnesota, and recently on the faculty of The Pennsylvania State College, was appointed to direct the genetics and cytology research, succeeding Dr. Hanson. Dr. Helen D. Hill, assistant in Cytogenetics, returned after a leave of absence. Other appointments were Mrs. Pauline J. Phelps, Secretary, and two part-time assistants, Francis L. Barnett in Genetics and Simon Baker in Agronomy.

Two resignations occurred among the collaborators. Dr. F. F. Lininger resigned to join the Food and Agriculture Organization of the United Nations. He was succeeded on the board of collaborators by Dr. M. A. Farrell, who also succeeded Dr. Lininger as Director of the Pennsylvania Agricultural Experiment Station. Dr. C. H. Moran resigned near the close of the year, having left the University of Maine to engage in commercial work. Mr. Cecil S. Brown will be the new collaborator from Maine.

No meeting of the collaborators was held in 1952 but many of them met and conferred with the Laboratory Staff at a number of conferences such as the NE-10 Forage Crop Technical Committee Conference, the Northeastern

Soil Research Committee, the Alfalfa Improvement Conference, the Conference on Rumen Function, and the Sixth International Grassland Congress. The last was the major event of the year in Pasture Research Activity, bringing over 1000 visitors from 49 countries to The Pennsylvania State College during the week of August 17-23. The Laboratory welcomed hundreds of visitors and sightseers to its building and field experiments during that week.

GENETICS, CYTOGENETICS, AND BREEDING

Orchardgrass

Inbreeding in *Dactylis glomerata*

Yields were obtained in 1952 from the space-planted test cross progenies. Although the agreement between the 1951 and 1952 results (1951 Annual Report, page 22) was relatively good, the test was not extensive enough to permit definite conclusions. Material is available for continuing this study.

Approximately 2,000 plants representing 145 I_6 and I_7 lines from 15 families were planted in the spring of 1952. This material will be screened for resistance to foliar diseases.

Comparison of Clonal, Polycross and Single Cross Progeny Tests for the Evaluation of Individual Plants of *Dactylis glomerata*

In 1952 yields were obtained from both the seeded and space-planted portions of this experiment (1951 Annual Report, page 22). The conclusions reported in the 1951 report were supported by the 1952 data. The average yields for two years indicate a good relationship between parent yield as spaced plants and progeny yield as spaced plants, and an equally good relationship between parent yield in "mass-seeded" plots and progeny in "mass-seeded" plots. Although there is a significant interaction of strains x methods of planting, the correlation between yields of strains at the two methods of planting was significant ($r = +.48$). The agreement between parent yield and polycross yield or restricted polycross yield was closer than that between parent yield and mean yield of all possible single crosses. If some single cross progenies contained a higher percentage of selfs than others, this would account for the poorer relationship between parent and single cross yields.

Comparison Between Methods of Evaluating Progenies of Dactylis glomerata

Yields and visual observations on vigor and disease were obtained in 1952 (1951 Annual Report, page 22). Data will be obtained and selections made in 1953.

Selection for Resistance to Foliar Diseases in Dactylis glomerata

The 29 plants selected for resistance to one or more foliar diseases (1951 Annual Report, page 7) were brought into the greenhouse in the fall of 1951 for selfing and crossing. In the spring of 1952, 24 of these clones were planted in 10 plant rows, replicated from 1 to 12 times.

Inheritance of Maturity in Dactylis glomerata

Notes were taken on time of heading in 1952. Heading data from three seasons are now available for this experiment (1950 Annual Report, page 30, and 1951 Annual Report, page 23). On the assumption of tetrasomic inheritance and chromatid assortment, the results indicate that a rather limited number of genes (possibly 3 or 4) governs the interval from initiation of growth to heading.

Inheritance of Quantitative Characters at the Diploid and Tetraploid Levels in Dactylis spp.

It is anticipated that seed obtained from greenhouse crosses made over the past 2 years will be planted in the spring of 1953 (1951 Annual Report, page 24).

Age of Pollen in Relation to the Frequency of Aborted Pollen, Micronuclei and Seed Set

As a continuation of studies reported in 1951 (The significance of temperature in interpreting determinations of micronuclei, 1951 Annual Report, page 24), heads were collected from 40 orchardgrass plants on each of 3 different dates, and from 16 of these on a fourth date. The frequency of micronuclei at the quartet stage has been determined together with the frequency of aborted pollen. Threshing samples for determining self and open pollinated seed set has not been completed.

Bromegrass

Selection for Increased Seedling Vigor in *Bromus inermis*

Four compaction experiments were completed during the winter of 1951-52 (1951 Annual Report, page 23). Seedlings were selected primarily on the basis of time of emergence, height, and vigor. In the fall of 1952, 112 selections obtained from these tests, together with commercial checks, were brought into the greenhouse for selfing and crossing.

Interspecific Relationships in *Bromus* spp.

Approximately 155 plants representing crosses made in the winter of 1950-51 and 42 plants from crosses made in 1951-52 are being grown in the greenhouse. These plants are being examined for interspecific hybridity. Although all of the seed was obtained from hand emasculated parents some of the plants appear to be obvious selfs (1951 Annual Report, page 25). Preliminary observations would suggest that the following hybrids may be included within this group of plants. *Bromus pumpellianus* (2n=42) x *B. erectus* (2n=42); *B. pumpellianus* x *B. inermis* (2n=56); *B. anomalus* (2n=14) x *B. frondosus* (2n=28); *B. anomalus* x *B. purgans* (2n=28); *B. grandis* (2n=14) x *B. purgans* and *B. grandis* x *B. laevipes* (2n=14).

Meadow Fescue and Perennial Ryegrass

Inheritance of Immunity from Crown Rust in Diploid *Festuca elatior*

More than 1700 seedlings representing the F_2 and backcross generations of crosses among resistant and susceptible plants were inoculated and classified from 2 to 3 times during the winter of 1951-52 (1950 Annual Report, page 32). Two of the original parents, 247(1) and 247(2), continued to give divergent results (1949 Annual Report, page 43). The results obtained from 247(1) indicate that 3 or 4 factors may govern rust resistance. Observations made in the greenhouse and field suggested that rust races may be complicating the inheritance study. This possibility is being investigated.

Hybridization of *Lolium perenne* and *Festuca elatior*

Time has not been available to complete the cytological examination of possible hybrids (1951 Annual Report, page 25). The crosses attempted between triploids (isolated from the cross between diploid perennial ryegrass and tetraploid meadow fescue) and tall fescue (2n=42) were not successful. Additional crosses will be made during the winter of 1952-53.

Ladino Clover

Isolation of Ladino Clover Plants Resistant to *Sclerotinia trifoliorum*

The greenhouse inoculation tests of single crosses among resistant and susceptible clones (1951 Annual Report, page 23) were completed. Altogether, 11,000 seedlings were tested in five separate experiments. The number of progenies in these experiments varied from 81 to 121 arranged in 4 replications of 5 plants each. In order to facilitate comparisons between trials certain single cross progenies, together with commercial checks, were common to all experiments.

The differences among progenies were highly significant in each of the 5 tests, while the differences between the averages of the resistant x resistant and susceptible x susceptible progenies were highly significant in tests 1 through 4, but not significant in the fifth test. The percentage of healthy survivors in the 5 tests is presented in Table 1.

The magnitude of the differences encountered among F_1 progenies derived from different parents but belonging to the same category with respect to resistance is illustrated by clones 28 and 40-9. On the average of the 5 tests, crosses involving 40-9 possessed 34.9 per cent healthy survivors, while all of the resistant x resistant progenies averaged 24.4 per cent. On the other hand, the average performance of clone 28 was consistently lower than the average of the resistant x resistant progenies. In the fifth test the performance of clone 28 was similar to that of the susceptible x susceptible progenies.

Table 1. Percentage of healthy survivors in five inoculation tests of single cross progenies (tests adjusted on basis of six per cent healthy survivors in commercial Ladino clover check).

Source	Total number of plants	Test 1	2	3	4	5	Average per cent
R x R	4005	28.5	26.5	32.0	17.7	17.1	24.4
R x S	2525	21.5	18.5	21.0	8.2	16.5	17.1
S x S	3230	12.0	4.0	13.0	11.0	11.7	10.3
R x R*	775	41.5	36.0	34.0	29.6	33.3	34.9
R x R**	947	26.0	20.5	28.0	17.7	10.8	20.6

* Crosses involving parent 40-9
** Parent 28

Two field experiments were planted in the spring of 1952, (a) a space-planted nursery consisting of 77 single cross progenies and commercial checks planted in 4 replications of 5 plants each, and (b) a plot experiment including 87 single cross progenies and commercial checks in 4 replications. The plots were 5 x 10 feet (50 seedlings were

transplanted at one foot spacings within plots). Both trials were inoculated with S. trifoliorum in the fall of 1952. These experiments were designed to study the practical importance of the level of Sclerotinia resistance obtained in this program.

Results from clonal plots planted in the spring of 1951 (1951 Annual Report, page 23) showed that some clones classified as partially-resistant in greenhouse trials also exhibited resistance when inoculated in the field.

Two hundred and fifty plants were isolated from the 5 greenhouse inoculation tests conducted during the winter of 1951-52. These selections are being screened in a greenhouse inoculation test, and the better clones will be used for crossing in the winter of 1952-53.

The Recombination of Characters in Trifolium repens

In the spring of 1952, 3,200 plants representing 109 single cross progenies were transplanted to a replicated nursery. The parental clones had been selected on the basis of persistency, size of leaves and petioles and stolon number. During the winter of 1952-53 additional test crosses will be made between plants selected primarily for field persistency and resistance to Sclerotinia.

Data were obtained from the Ladino clover observation nursery (1951 Annual Report, page 13). Satisfactory persistency ratings are not available as very few plants were lost during the winter of 1951-52. The only severely damaged source was the white clover entry from Irazu, Costa Rica (P.I. 193164). Two of the most vigorous sources were Eastern Oregon (F.C. 24068) and Breeders Ladino (F.C. 24075). An appreciable number of off-type (small) plants were found in Non-Certified California (F.C. 24,129) and California Northern (F.C. 24,126).

Inheritance of Leaf Coloration in Trifolium repens

Seed from crosses made in the greenhouse during the winter of 1951-52 has been planted for classification (1951 Annual Report, page 24).

Alfalfa

Alfalfa Breeding

Vigor and disease ratings were obtained from the space-planted progeny test distributed under NE-10 (1951 Annual Report, page 10). The progenies differed in vigor, leafhopper damage, and amount of leafspot (mainly black stem). Some of the progenies receiving good color ratings (less yellowing) were NY 49-67, C 44, NY 49-13, and NY 49-29. Progenies with low leafspot readings would include C 57, C 186, Narragansett, and NY 49-20. Eight superior plants were selected for selfing.

Inheritance of Flower Color in Medicago sativa

Preliminary investigations were not successful in supplying a rapid chemical procedure that could be used in the classification of flower colors (1949 Annual Report, page 43). In view of the conflicting evidence available in published reports, however, work was initiated on the inheritance of white flowered alfalfa. Six white flowered plants were selected in 1952 and brought into the greenhouse for selfing and crossing. Open pollinated seed collected in the field from these selections was used to establish limited progenies for selfing.

The Relation of Meiotic Behavior to Seed Set in Medicago sativa

Racemes were collected on each of two dates from 42 alfalfa clones (including 12 C-clones). The frequency of aborted pollen was determined at three stages of development (immediately after the quartets had separated, an intermediate stage, and mature pollen). The frequency of univalents, multivalents, and chiasmata at diakinesis has been recorded for 24 plants from aceto-carmine smears. The percentage of cells with univalents ranged from 22.2 to 70.0 per cent while the average number of univalents per cell ranged from 0.44 to 2.60. Quadrivalents were present in 12.5 per cent of the cells examined, and the average number of quadrivalents per cell per plant ranged from 0 to 0.36. The average number of half chiasmata per chromosome was 1.32 (range 1.48 to 1.20). The frequency of univalents at diakinesis was significantly correlated with chiasma frequency (-0.57) and quadrivalent frequency (-0.49). Data on self and open-pollinated seed set are being compiled.

PLANT PATHOLOGY

Purple Leafspot of Orchardgrass

Studies were completed and published on symptoms and host range of disease, physiology, and survival of the pathogen (Stagonospora maculata), and certain host-parasite relationships.

In determining the effects of environment on disease development, orchardgrass plants held at different temperatures were kept moistened at various intervals after inoculation. Some infection occurred when the plants were kept at 100 per cent relative humidity for only 6 hours at 20°-26°C and then dried with forced air. The number of lesions increased 20-fold when the high humidity period was increased to 12 hours. The disease incidence continued to increase, to a lesser extent, up to 72 hours. In these tests, pieces of leaf tissue were examined

microscopically 6, 12, 24, and 48 hours after inoculation. After 6 hours, 65 per cent of the spores had germinated and 11 per cent had produced appressoria or were entering stomates. Within 48 hours, 88 per cent had germinated and 73 per cent of these were penetrating the epidermis. The rapidity of infection by the fungus over a wide range of temperature may explain the prevalence of the disease.

Helminthosporium Leaf Streak of Timothy

Studies are being continued on the previously unreported disease of timothy (1951 Annual Report, page 27). In the greenhouse the fungus, identified as Helminthosporium catenarum, failed to infect any of the other common forage grasses but caused severe damage to timothy. The disease was prevalent in Central Pennsylvania during the summer of 1952, killing the lower leaves of susceptible plants. Often it was associated with damage due to other agents, e.g. drought or other injury.

Studies on Pseudopeziza medicaginis and Ascochyta imperfecta

Studies are being continued on Pseudopeziza leafspot and black stem in relation to their economic importance, the selection of highly resistant lines, and interpretation of the inheritance of resistance. In a spaced plant experiment (1951 Annual Report, pages 26-27) two hay cuts were made in 1952. In the second cut the leaf/stem ratio was determined by samples taken from each plot in addition to the fresh and dry weights. During the season some clones were moderately diseased with black stem while only a trace of Pseudopeziza leafspot was evident. In the replications dusted with "tribasic" copper sulphate the incidence of black stem and the amount of defoliation were greatly reduced. A correlation coefficient of -0.87 was obtained between leaf yield and black stem incidence.

Stemphylium Disease of Birdsfoot Trefoil

The fungus causing a leafspot and stem canker of birdsfoot trefoil (1951 Annual Report, page 27) has been identified as a new species of Stemphylium. It has been designated Stemphylium loti N.sp. The fungus differs from S. sarcinaeforme, which causes a leafspot of red clover, principally in host range, spore and mycelial color, rate of mycelial growth, and production of stromatic bodies in vitro and in viva. S. loti overwinters on seed and on plant refuse. As high as four per cent of the seed from one lot was infested with the pathogen. No highly resistant plants have been found.

Virus-like Disease of Birdsfoot Trefoil

A disease which appears to be caused by a virus was found on birdsfoot trefoil at State College in 1952. The leaves are mottled and later become yellow. Under certain environmental conditions, e.g. high temperature, symptoms may disappear completely. Further studies are in progress.

Field Inoculations of Red Clover with *Sclerotinia trifoliorum*

The field experiment on the rate of application of dried grain inoculum of *Sclerotinia trifoliorum* (1951 Annual Report, page 12) was repeated in 1952. The inoculum was broadcast over plots of Pennscott red clover in late fall. The number of replications was increased to 8 in 1952.

The percentage of plants which survived the various rates of grain inoculum is shown in Table 2.

Table 2. Percentage survival of red clover plants in field plots inoculated with *Sclerotinia trifoliorum*.

Rate c.c. per sq./ft.	Percentage of survival 1951	1952
0.0	100	100
0.5	86	34
1.0	84	36
2.5	63	10
5.0	64	7
7.5	43	6
10.0	55	5
15.0	37	3

The dissimilarity between the two years is attributed to the differences in environmental conditions. The winter of 1950-51 was severe with little snow whereas the following winter was milder with more snow cover, thus being much more favorable for growth of the fungus.

Physiological Studies of *Sclerotinia trifoliorum*

Under certain conditions, *Sclerotinia trifoliorum* will give rise to a variant which does not incite crown rot of clover, and fails to produce sclerotia. Experiments were undertaken to reveal any differences in the physiology of a normal isolate of *S. trifoliorum* and its non-pathogenic variant which might help to explain why the former is pathogenic while the latter is avirulent. Tests carried out thus far indicate

that the ability of the two strains to grow on a variety of media is very nearly the same. Both organisms were able to utilize seventeen out of eighteen amino acids used singly as the only source of nitrogen in a basal medium. While growth varied considerably depending on the amino acid used, the normal and degenerate strains showed a very similar response with any given amino acid.

Certain amino acids were shown to have an inhibitory effect on the formation of sclerotia by the normal isolate.

A study of enzyme formation by the two strains has been initiated.

PHYSIOLOGY AND BIOCHEMISTRY

Carbohydrate Studies on Grasses

Studies on the polysaccharides of orchardgrass were continued (1951 Annual Report, page 28). Holocellulose, prepared by the chlorite treatment of grass cut at the flowering stage, was treated successively with hot water, cold 0.5 per cent KOH, and cold 1.5 per cent KOH, each for 72 hours. Precipitates were obtained from each filtrate on acidification, and on addition of alcohol following neutralization, and on evaporation of the liquors. A series of hemicellulose fractions were thereby obtained from the holocellulose and their composition is being studied to give insight into the structure of orchardgrass hemicellulose. The extracting reagents were less severe than those customarily used and were chosen not to effect quantitative removal of hemicellulose but to insure the purity of that obtained.

These fractions have been analyzed for alpha-cellulose, free cellulose, lignin, protein, and ash. To be determined are uronic acid, pentosan, reducing power, methoxyl, and sugars, the last both qualitatively and quantitatively by paper chromatography. Some 20 per cent of the lignin originally present in the grass was found in the holocellulose in spite of four acid-chlorite treatments of 15 minutes each at 85°C and very little of that was removed from the holocellulose by the hemicellulose extractions.

Conclusions drawn from the cellulose analyses are that free cellulose was left nearly intact by the extraction procedure but about 10 per cent of the alpha-cellulose was attacked. It is possible that the major portion of this loss is cellulosan and evidence is to be sought whether cellulosan is or is not hemicellulose.

The Chemical Composition of the Pasture Grasses

(In cooperation with T. G. Phillips of the New Hampshire Station)

Studies have been continued on grasses growing in small plots (1951 Annual Report, page 13). In 1952 cuttings from new plantings established late in 1950 were taken whenever the grass in a plot reached grazing height. Nitrogenous fertilizer was added individually to each plot after that plot was cut rather than to the whole area at once as was done in former years. Dry weather handicapped growth during the summer but was partially corrected by irrigation. The numbers of successive cuttings during 1952 were as follows:

Alta fescue	7
Bromegrass	5
Kentucky bluegrass	6
Orchardgrass	8
Reed canarygrass	5
Redtop	4
Timothy	6
Tall oatgrass	6

To supplement the 1950 data, analyses of the cuttings will be made for the major organic substances. Statistical studies are being continued on the data of previous years. The results of 1948 and 1949 harvests are being prepared for publication.

Chemical Composition of Legumes

The composition of pasture legumes was studied from the standpoint of their nutritional and edible properties and with regard to the habits of grazing animals. Miscellaneous samples of alfalfa, Ladino clover, and birdsfoot trefoil were analyzed for simple carbohydrates and nitrogen compounds. Comparisons between species were not conclusive but all three legumes contained a high proportion of dry matter soluble in alcohol, higher in some samples of birdsfoot trefoil and Ladino clover than has been found in grasses. Total nitrogen was not higher in legumes than has been found in foliage of immature grasses under conditions of good fertility, but the proportion of the total nitrogen soluble in alcohol was higher than that usually found in grasses. The terminal shoots and upper leaves of alfalfa had more soluble dry matter, total nitrogen, and sugars, than the whole above-ground part of the plant but had proportionally less of its nitrogen in the alcohol soluble fraction. Drying alfalfa foliage in the sun under glass caused a moderate, and drying in the oven a large, increase in the proportion of soluble nitrogen. These findings are preliminary and further comparisons are to be made.

Measurement of the Nutritive Value of Pasture Plants

After digestibility trials were carried out with sheep at the Pennsylvania station, samples of the forage fed and of the feces are being further analyzed in order to determine coefficients of digestibility of substances not determined at the time of the digestibility trials. Coefficients of digestibility for cellulose were reported last year (1951 Annual Report, pages 15 and 16). These analyses will be continued. Lignin is being determined also and these samples of forage and feces are used for a study of the method for the determination of lignin. To date no modification of the lignin method of Ellis, Matrone, and Maynard has been successful in lowering the values for apparent digestibility of the lignin. Its low digestibility makes it valuable as a criterion of quality of herbage but the fact that it does have some slight and variable digestibility makes it unsuitable as a reference substance in digestibility trials. Results also indicate that lignin, in its passage through the sheep is altered and becomes less resistant to the action of strong acids. Further studies will be directed toward finding a more rapid method of determination of a substance, so-called lignin, which will have a coefficient of digestibility as low as possible.

Cutting Practices as They Affect Carbohydrate Reserves in Alfalfa and the Persistence of the Stand

An experiment was begun to determine whether alfalfa stands can be maintained when the first cutting for hay is made earlier than the commonly used "tenth-bloom" stage, thereby improving the quality and seasonal distribution of the harvested forage. First cuttings were taken at five stages of growth: prebud, early bud, late bud, early bloom, and full bloom. The subsequent cuttings were taken when the plants, after the various first cuttings, had reached the half-bloom stage. Samples of roots from plants given each of the cutting treatments were taken to determine the effect of the cutting variables on carbohydrate storage.

Plant Climate Studies

Measurements of air temperatures at several heights over a Kentucky bluegrass sod clipped at a height of 1.5 inches above the ground indicated height relationships similar to those observed previously (1950 Annual Report, pages 36 and 37, and 1951 Annual Report, pages 29 and 30). During 1952 primary emphasis was given to diurnal changes in the dewpoint and relative humidity as affected by the interrelationship of clear, partly cloudy, and cloudy days, height above the ground, and the conditions within a stand of alfalfa. Data obtained during July, which was warm and dry, indicated that the dewpoint (the temperature at which water vapor will condense out of the air) was highest near the grass sod and decreased progressively at heights of 3 inches, 6 inches, and 5 feet (Table 3). In alfalfa stands, the dewpoints, at

3 inches above the ground, were similar to those at the 1.5 inch height over bluegrass.

Large diurnal changes in dewpoint occurred 1.5 inches above the ground but at 5 feet the dewpoint was relatively constant (Fig. 1). The moisture contents of the different air masses prevailing over this area on clear and on cloudy days are indicated by the low dewpoint on clear days and a higher dewpoint on cloudy days. From the dewpoints (Fig. 1) and air temperatures (Fig. 2) determined at the same places, relative humidities were calculated (Fig. 3).

It is evident that near ground level relative humidities reached 100 per cent at night under both clear and cloudy conditions but at the 5-foot height this did not occur. On partly cloudy days, conditions were intermediate at all heights.

Table 3. Dewpoints and Relative Humidities of the atmosphere at different heights above ground. (Values are averages obtained from bi-hourly readings of temperatures and dewpoints, July 1952.)

Height above ground	Clear*		Partly Cloudy**		Cloudy**	
	Dewpoint °F	RH per cent	Dewpoint °F	RH per cent	Dewpoint °F	RH per cent
Over Kentucky bluegrass sod clipped at 1.5 inch height						
1.5"	66	70	72	81	72	87
3"	61	63	68	73	69	81
6"	59	57	65	68	67	75
5'	57	53	64	62	66	72
In alfalfa to be cut for hay						
3"	64	66	71	78	71	87

* Average of 12 days
** Average of 7 days

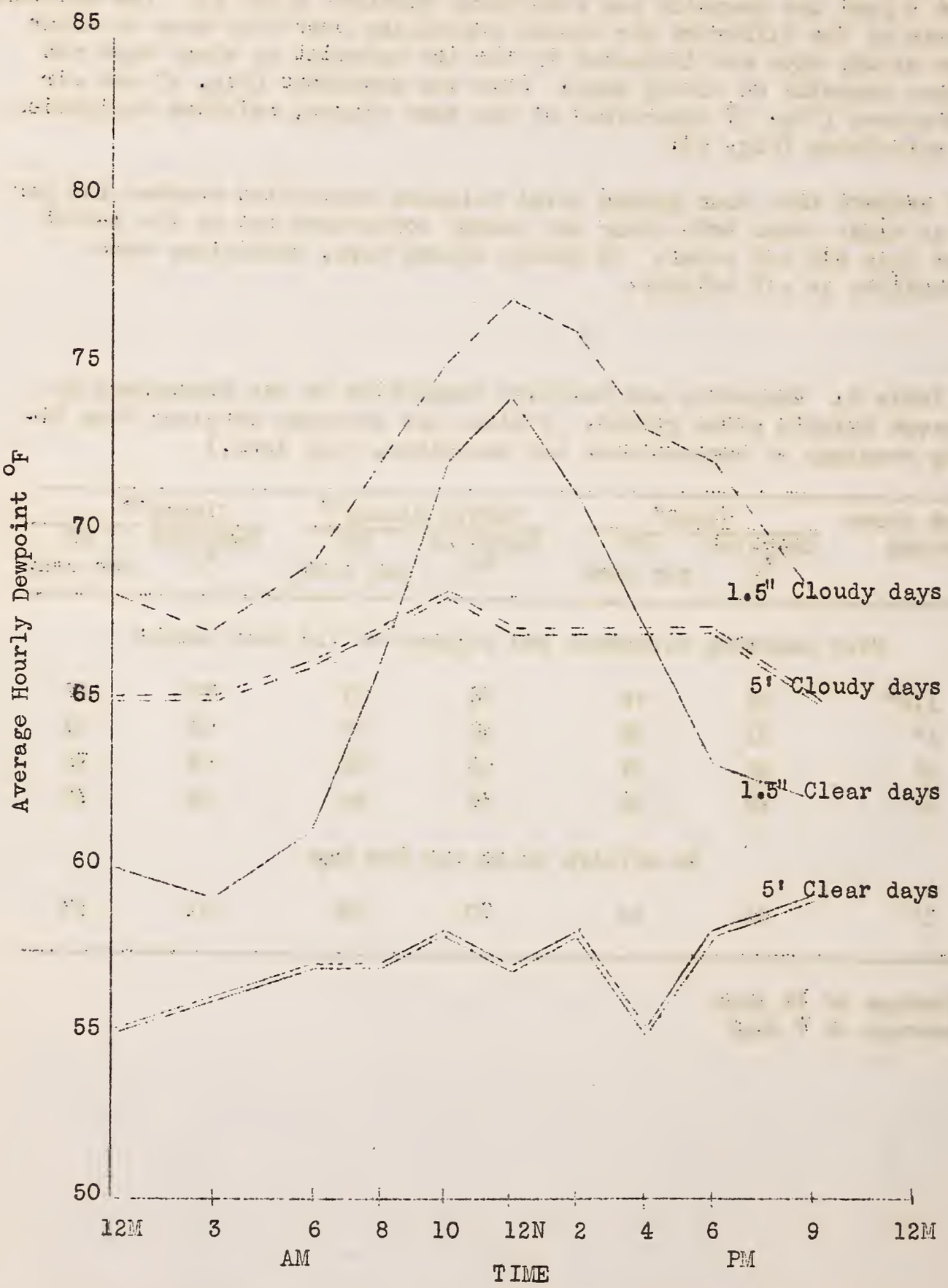

Figure 1. Diurnal changes in dewpoint temperatures over a bluegrass sod at 2 heights above ground on clear days (average of 12) and on cloudy days (average of 7), July 1952.

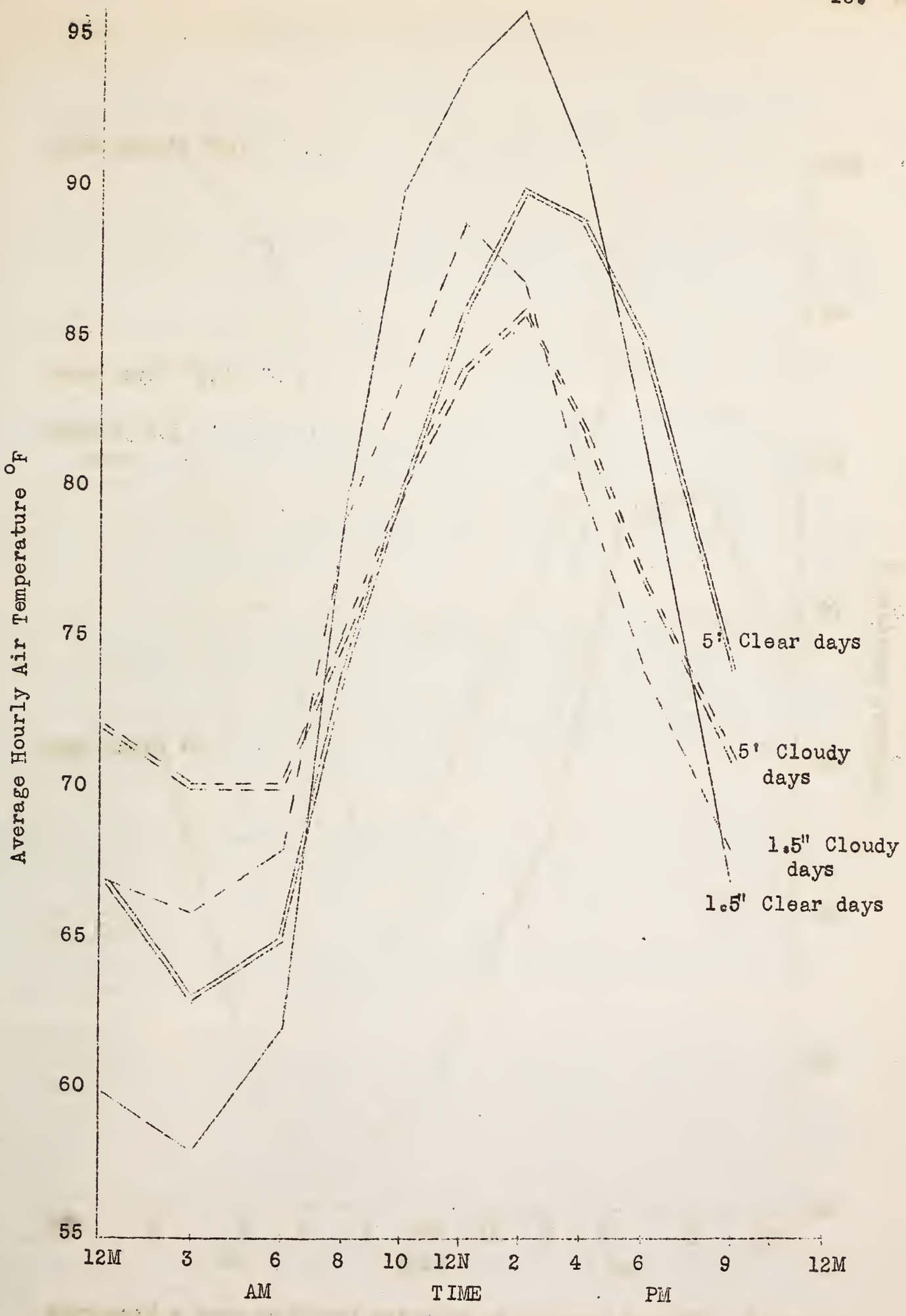

Figure 2. Diurnal changes in air temperatures over a bluegrass sod at 2 heights above ground on clear days (average of 12) and on cloudy days (average of 7), July 1952.

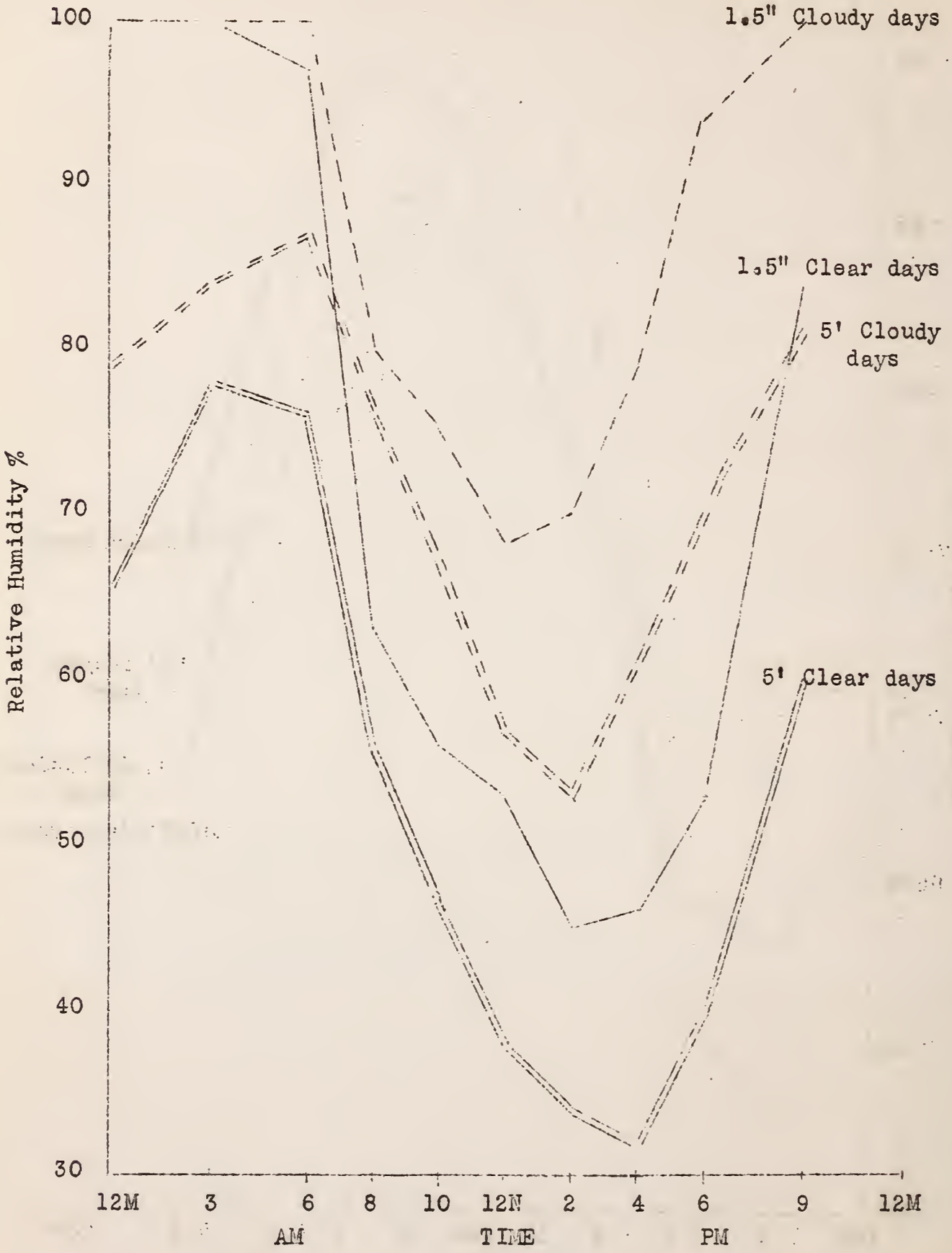

Figure 3. Diurnal changes in relative humidity over a bluegrass sod at 2 heights above ground on clear days (average of 12) and on cloudy days (average of 7), July 1952.

Regional Microclimate Studies

In cooperation with T. S. Ronningen and A. O. Kuhn (Maryland), E. R. Biel and J. E. Carson (New Jersey), H. A. MacDonald (New York), A. R. Midgley and K. E. Varney (Vermont), and G. G. Pohlman and E. L. Galpin (West Virginia).

Air temperatures, rainfall, soil moisture, relative humidities, and other microclimatic conditions are being recorded at the above locations in the Northeastern Region. These data provide descriptions of environmental conditions in the states which are also conducting the cooperative NE-10 variety and strain trials and will aid in explaining growth responses at each location. Even greater use of these data will be made in the interpretation of interactions between locations and years.

Temperatures: From a comparison of the semi-monthly temperature distributions it is evident that the pattern is similar at each of these six stations through the period from May 1951 through November 1952. Both mean maximum and mean minimum temperatures for the summer months in 1952, and especially during July 1952, were much higher than in 1951. These high temperatures further decreased soil moisture that was already limited by low precipitation.

Of the six stations College Park, Maryland, and New Brunswick, New Jersey, experienced the highest midsummer air temperatures during 1952. At State College, Pennsylvania, records showed that the stolons of Ladino clover attained temperatures above 120°F for several consecutive days during August. On August 3 the stolon temperature reached 123°F whereas the air temperature at a 3-inch height over bluegrass sod was only 93°F and at a 5-foot height only 87°F.

At all stations air temperatures near the soil surface were higher during the day and lower at night than at a 5-foot height (as reported by the Weather Bureau). Mean daily ranges in air temperature were much greater near ground level than at 5 feet. The range was greatest during the summer and least during late fall, winter, and early spring. Slightly greater daily ranges occurred both in summer and winter in Maryland and West Virginia than in Vermont and Pennsylvania. In New Jersey, conditions were intermediate.

Precipitation: Rainfall in 1952 until early June was generally adequate for good growth, except perhaps at Aurora, New York. Moisture in West Virginia was not seriously limiting until the latter part of August, September, and the first 3 weeks of October. At State College, Pennsylvania, and College Park, Maryland, moisture became limiting during June and July and the fore part of August. Similarly, moisture limited growth at Burlington, Vermont, during July and early August, and again in September and October. At Aurora, New York, rain during July improved growing conditions only slightly due to abnormally high temperatures. Over the entire region rainfall was limiting from mid-August to November.

Conditions during the winter of 1951-52 were generally favorable for survival of forage plants in Vermont and Pennsylvania. In West Virginia lack of snow cover and high soil moisture resulted in frequent heaving. Records of winter conditions in Maryland, New Jersey, and New York are not yet available.

Relationship of Temperature and Daylength to Heading in Perennial Grasses

During the winter of 1951-52 studies similar to those previously reported (1951 Annual Report, page 31) were conducted to determine effects of temperature on heading and flowering of early and late clones of orchardgrass, meadow fescue, bromegrass, reed canarygrass, and timothy. Tillers from each clone were rooted in running tap water and planted in fertile greenhouse potting soil. Five replicate pots of each clone were grown under all possible combinations of the following temperatures and photoperiods: (1) pretreatment for 28 days under short fall daylengths at greenhouse temperatures of 55°, 65°, and 75°F (2) long-day treatment for 71 days under 16-hour daylengths and temperatures of 55°, 65°, and 75°F. Records were taken of the time of initiation of floral primordia, time of heading and flowering, and the number of culms producing heads. The effects of temperature during the short-day periods were pronounced in orchardgrass and bromegrass. Floral primordia were initiated 3 or 4 days sooner on plants pretreated by growing at 55°F than on those grown at 75°F.

Temperatures of 55°F during the long-day period delayed initiation of floral primordia in all species. The times of heading and flowering were delayed from 12 days to a month or more by low temperatures under long daylengths. The number of panicles produced by all species except timothy was influenced by the temperature of the short-day pretreatments; high temperatures during short days greatly decreased the number of panicles.

Orchardgrass, meadow fescue, and reed canarygrass initiated floral primordia, headed, and flowered earlier when subjected to temperatures of 55°F under short days and then subjected to temperatures of 75°F under long days than under any other treatment. Timothy was not greatly affected by temperature under short days but headed and flowered sooner when maintained at 75°F under long days.

Growth Responses of Ladino Clover Under Low Light Intensities

Seedling progenies of Ladino clover clones previously classified on their reaction to low light intensity (1950 Annual Report, page 30, and 1951 Annual Report, pages 23 and 31) were grown for 112 days under 16-hour daylengths, provided by white fluorescent lamps supplying light at an intensity of 150 foot candles at the soil surface. The seedlings were not clipped prior to or during the experimental period.

In contrast to clonal material used in previous experiments, only a few seedlings died as a direct result of low light intensity. Damping-off appeared to be the major cause of death. Further studies are planned to determine the main effects of and interactions between light intensity, temperature, humidity, and disease on the survival of Ladino clover seedlings. To obtain additional plant progenies for use in trials, 32 plants were selected for intercrossing.

Rate and Frequency of Potash Application on Dactylis glomerata

Potassium uptake by orchardgrass and residual exchangeable potassium in the soil were determined for plots on Hagerstown silt loam that received potassium at various rates and frequencies. All plots received lime, phosphate, and nitrogen (1951 Annual Report, page 32).

Soil tests showed that potassium fertilizer had a marked carryover effect from one year to another. At the end of three years, exchangeable potassium in the 0-3 inch soil layer averaged 103, 143, and 324 parts per 2 million, respectively, on plots that received 0, 50, and 100 pounds per acre of potassium per year. Differences below the 3 inch depth were much less marked. Plots that initially received 150 pounds per acre of potassium tested as high in exchangeable potassium at the end of three years as plots that had received 50 pounds per acre per year.

Potassium absorption by the grass also indicated marked carryover effects. Where 50 pounds of potassium per acre was applied annually the calculated percentage annual recovery of potassium was 38, 64, and 107 per cent for the first, second, and third years, respectively. Where 150 pounds of potassium was applied initially, 19 per cent of the 150 pounds was recovered the first year, 19 per cent the second, and 22 per cent the third year.

The potassium recovered in the herbage from the fertilized plots in excess of that recovered from the control plots, plus the residual exchangeable potassium in the soil was approximately equal to the total potassium applied.

Responses of Grasses vs Legumes to Phosphorus and Potassium Fertilization

Previous investigations had shown that under greenhouse conditions seedlings of the common forage grasses responded more to phosphorus than did legume seedlings.

This year field plots were established on a depleted soil to determine the response of orchardgrass and of alfalfa to increasing levels of phosphorus and potassium fertilizers. The entire area was well limed, and on plots where phosphate is being evaluated potassium was applied. Similarly phosphorus was applied uniformly to plots used for evaluating responses to potassium. The two species were seeded alone and in association. Nitrogen fertilizer was applied to all plots of orchardgrass.

Seedlings of each species showed very marked increases in rate of growth from both phosphorus and potassium applications. Owing to extremely dry weather no yield data were obtained in the year of seeding.

Factors Affecting the Establishment of Ladino Clover in an Old Orchardgrass Sod

Investigations of the effects of fertilization, clipping treatments, and moisture levels on the establishment of Ladino clover in an old orchardgrass sod on a Hagerstown silt loam soil were continued. In these trials the Ladino clover was broadcast early in the spring without tillage (1951 Annual Report, page 33).

The data on yield and stand estimates of Ladino clover indicate that nitrogen fertilization was the most important single factor limiting the establishment of the clover. On plots receiving nitrogen fertilization and cut for hay, the stands of Ladino clover were practically a complete failure. Close clipping of the grass markedly increased the stand of clover. However, even with severe clipping the depressing effect of nitrogen on clover establishment was very striking. High fertilization with phosphorus and potassium did not overcome the depressive effect of nitrogen fertilization.

The best stands of Ladino clover were obtained with low levels of nitrogen fertilization and severe clipping, particularly when phosphorus and potassium were added.

The results of these field trials indicate that under proper management and fertilization practices it may be possible to reestablish Ladino clover in an orchardgrass sod without tillage. The effect of added nitrogen upon the clover is not clearly understood from this study. However, the results do indicate that competition by the associated orchardgrass for nutrients and moisture alone does not adequately explain the depressing effect upon the establishment of Ladino clover when the growth of the orchardgrass is stimulated by nitrogen fertilization. Therefore, a greenhouse study of the importance of shading and soil aeration in the establishment of Ladino clover in an orchardgrass sod is being conducted at present in order to determine more precisely why added nitrogen is detrimental to establishment of Ladino clover.

Irrigation of Grasslands

Experiments were started to determine the effects of the following variables on responses to irrigation: (1) plant species, (2) soil moisture content at the time of irrigation, and (3) soil conditions affecting depth and extent of root development.

The experiment is being conducted in glazed clay sewer tile, 18 inches in diameter, and set vertically in the ground to extend 24 inches below the soil surface. Each tile was partially filled with subsoil, followed by a 6-inch layer of well fertilized topsoil. The subsoil was initially acid and very low in fertility but by adding lime and fertilizer it was possible to provide different levels of acidity and soil fertility. Krilium was used for certain treatments to provide differences in soil structure. The plant species are alfalfa, orchardgrass, and Kentucky bluegrass.

Gypsum blocks were installed in each tile at depths of 4, 8, 12, 18, and 24 inches. During midsummer the area will be protected from rainfall by movable glass-o-wire covers. Irrigation to bring the soil to field capacity will be applied when the soil reaches various predetermined moisture levels. The area immediately surrounding the tile will be seeded to minimize border effects. Yield of dry matter will be used to measure the responses obtained.

RESEARCH OF THE

DIVISION OF FORAGE CROPS AND DISEASES

Beltsville, Maryland

Title: SELECTION, INBREEDING, AND CROSSING TO OBTAIN ORCHARDGRASS STRAINS ADAPTED PARTICULARLY FOR PASTURES (1951 Annual Report, pages 4-7)

Leader: R. E. Wagner

Nursery of Spaced Plants: The present nursery consisting of 72 selections from old polycross nurseries and 6 selections from a miscellaneous nursery was observed and notes recorded on vigor, recovery after cutting and rust resistance. On the basis of this and previous years' notes 39 clones were selected. In addition to being outstanding in other characteristics, a number of clones have exhibited considerable resistance to rust. Particularly consistently outstanding in this respect has been clone XXXVI-15. Of the 39 clones selected, 28 were also superior in progeny tests. The remaining 11 were not included in progeny tests.

Plans are now under way to put some of these selected clones together as a potential new strain or strains.

Progeny Tests: Three years of data have now been collected on the orchardgrass progeny tests. In maturity Group I, where the grasses were grown in pure stand, Beltsville, XXXIII-40, AI-4, AI-12, and AI-19 were in the high yielding group and all were significantly more productive over the three-year period 1950-52 than Arizona, Commercial, and S-143. Considering only last cuttings of each year, which is a measure of production from the last of July until the middle of October, Beltsville, S-143, and XXXIII-40 were most productive. Commercial, Arizona, XXI-5, and XXXI-9 were lowest of the group. Annual average yields of the last cutting were 1.13, 1.10, and 1.04 tons per acre

for Beltsville, S-143, and XXXIII-40, respectively; and 0.53, 0.70, 0.73, and 0.76 tons per acre for Arizona, XXXI-5, Commercial, and XXXI-9, respectively. All of the latter group were significantly lower in production than the former.

When grown with Ladino clover, differences in yields of the strains were less than when grown alone, presumably because of the compensating effect of the clover. Differences between average annual seasonal yields of strains in the various maturity groups were not great, although those in Group IV tended to be least productive.

Within Group I where the strains were grown with Ladino clover, Wisconsin 52, AI-4, XXXI-14, Syn. 1, and S-143 were high yielding. Commercial and Arizona were low. In Group II, XXXIV-31, XXXIV-18, and XXXV-9 were high, and Commercial, AII-2, and XXXIV-28 low. Among strains in Group III, XXXVI-28, XXXVI-25, and XXXV-5 were most productive. Tammisto and Finnish Late Hay were least productive. In Group IV, there was no significant difference among strains, but XXXVII-18, XXXVII-2, and XXXVII-11 were high yielders, while Syn. 5, S-37, XXXVIII-21, XXXVIII-22, XXXVIII-25, and Commercial were low in productivity.

Probably the greatest difference in strains, other than their difference in late summer and fall growth already indicated, was in their resistance to rust. XXXII-16 has been consistently outstanding in this respect. Beltsville, S-143, AI-12, AI-19, XXXI-9, and XXXI-19 also showed considerable resistance to rust.

Further Selection and Increase of the Beltsville Strain: In the fall of 1952, 548 plants were transferred from the old increase block to a new area to establish a new increase block of the Beltsville strain. Each of these plants was divided into 5 clonal pieces, so that the new block represents approximately 2700 plants on nearly three-fourths of an acre. This will serve as a source of breeders seed of the strain.

REPORT OF COOPERATIVE RESEARCH

Title: PROJECT NE-10 - ADAPTATION, MANAGEMENT AND UTILIZATION OF FORAGE CROPS IN THE NORTHEAST. SUB-PROJECT 1 - THE EVALUATION OF FORAGE CROPS VARIETIES AND STRAINS FOR THEIR USE AND ADAPTATION IN THE NORTHEAST.

Leader: H. R. Albrecht, Chairman, Regional Technical Committee

Cooperators: Connecticut, Delaware, Maine, Massachusetts, Maryland, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, West Virginia Agricultural Experiment Stations and Pasture Research Laboratory.

Evaluation of Varieties and Strains

There are certain broad generalizations applying to the results with all species that may well be emphasized. An inherent feature of the experimental design and methods and conditions of testing employed in these trials was the possibility of obtaining information on the essential elements of an adequate forage crops variety testing program. This series of trials provides perhaps the first extensive evidence including varieties of several species that are tested in individual associations with commonly associated species and under the one or two usual management practices.

From the data obtained in both 1951 and 1952 (1951 Annual Report, pages 3 and 4; 1950 Annual Report, pages 3 and 4; 1949 Annual Report, pages 3 and 4) two points in the results may be stressed:

(1) As a general rule the varieties x associations interactions were seldom significant. In those first two year's results, variety performances have been relatively similar regardless of association. Variety yield trials may justifiably be conducted with only a single association (which may, in the case of grasses, be alone and fertilized with nitrogen).

(2) The varieties x managements interactions were similarly seldom significant. The conclusion may be drawn that varieties of a species which will be subjected to diverse management treatments may well be evaluated under a single, convenient, but realistic set of management conditions. It may be desirable and necessary to develop experiments designed to measure persistence of varieties under rigorous pasture management.

Ladino Clover: Two of the original five entries, California Improved and Montana Certified, were eliminated from the test in 1952. Of the three remaining varieties, the Aberdeen, Idaho (F.C. 23,608) proved to be slightly more productive at some locations than the Oregon Certified and the Italian Composite. The Aberdeen strain also proved to be more persistent, i.e., less subject to winterkill. Dry weather of the

summer reduced yields substantially especially in Rhode Island, New Jersey, and Pennsylvania. "Fusarium sp. occurring on Ladino grown on gravelly, drouthy areas at Rhode Island effected a 100 per cent kill of Ladino clover."

Birdsfoot trefoil: Except for Vermont where varieties did not differ significantly, both Viking and the Italian entry consistently outyielded the Empire. This was the case under all managements and associations. Viking and Italian did not differ significantly, adding credence to the 1951 statement that the Italian type used in this test may be adapted to Northeastern conditions.

Consideration of the birdsfoot trefoil component of yield shows that for some locations brome was less competitive than timothy and for other locations this was reversed. Orchardgrass was most competitive at all locations. The silage management gave somewhat higher yields than the pasture management with birdsfoot trefoil.

Alfalfa: The performances of varieties were relatively similar when grown alone or in association with bromegrass or timothy. Narragansett was in the group of superior yielding varieties in New York, Pennsylvania, Rhode Island, Vermont, and West Virginia. Northern Synthetic produced upper bracket yields in New Jersey and Vermont and was satisfactory in New York and Pennsylvania. Atlantic was the top yielder in New Jersey and gave satisfactory yields in New York, Maryland, and Pennsylvania. The performance of Buffalo was poor in every state except New Jersey. Williamsburg was outstanding in Maryland.

The differences among varieties are greater for the alfalfa fraction of yield than for the total yield. This is a manifestation of the tendency for differences in variety yields to be compensated by differential yields of an associated grass. Bromegrass gave greater competition to the alfalfa varieties than Timothy.

Narragansett and Northern Synthetic showed lower incidences of leaf and stem diseases. Bacterial wilt had begun to reduce stands of Narragansett and Grimm in New Jersey.

The results of the alfalfa trials seem to indicate greater differences within the Northeast Region with respect to the adaptation of alfalfa varieties than is true of other species tested. This may indicate need for a greater number of varieties of this species to best meet the needs of the Region.

Red Clover: Results from 1951 plantings were available from one location each in Pennsylvania, Rhode Island, and Vermont. Similar relationships among varieties existed whether the varieties were grown alone or in association with timothy.

As an average of the three locations, Pennscott was highest yielding. It was outstanding in Pennsylvania and Rhode Island. In Vermont, Pennscott and Dollard were about equal in yielding ability.

As an average for the Region, the red clover fraction from the timothy association was nearly equal to the yield of red clover grown alone. Thus it appears that the yield of the timothy association is over and above the yield that may be expected from red clover alone and that the competition of the timothy to the red clover has been small during the past two seasons.

1950 seedings in New York and Rhode Island showed some survival into the third year for Dollard in New York and Dollard and Kenland in Rhode Island. Pennsylvania results showed a superior survival of Pennscott.

Orchardgrass: The varieties x associations interaction was significant for many of the analyses presented. However, in general, the interaction was the result of much smaller differences among the varieties when grown in association with Ladino clover than when grown alone and fertilized with nitrogen. In many instances this was the consequence of winterkilling of the Ladino clover or reduced growth of the Ladino clover as a result of hot dry weather. The varieties tended to maintain the same ranking under the two methods of testing.

As in 1951, Commercial orchardgrass, Beltsville and the Early Synthetic were highest yielding. They were followed in descending order by the Medium Synthetic, Brage, Late Synthetic, and Finnish Late Hay. Yields were directly related to earliness of maturity as in 1951.

Fertilizing with nitrogen gave a total production of approximately one ton more of dry matter per acre than that obtained with Ladino clover as the source of nitrogen, as an average for the Region. Results at Rhode Island were a notable exception.

Beltsville was outstandingly superior in resistance to foliar diseases.

Bromegrass: The differences among bromegrass varieties were greater when the varieties were grown alone than when grown with either Ladino clover or alfalfa, but the rankings tended to remain similar. The F values for varieties were generally greater for the bromegrass fraction of yield than for total yield. This shows that differences among variety yields were compensated in part by differential yields of the associated legume.

Achenbach and Fischer were the top yielding varieties followed rather closely by Lincoln, a third southern type bromegrass. Both Manchar and Martin gave similar yields and approached the southern types in yielding ability. The northern type commerical was a poor last.

The combination of bromegrass plus alfalfa gave the highest total yields in Maryland, New Jersey, New York, Vermont, and Rhode Island. Bromegrass grown alone and fertilized with nitrogen gave the highest yields in Pennsylvania.

Timothy: In New York, Maryland, Pennsylvania, and Vermont the highest total yields were obtained where timothy was fertilized with nitrogen. Timothy grown with Ladino clover gave the highest total yields in New Jersey, West Virginia, and Rhode Island. The relative variety performance was similar regardless of association.

There were significant differences in variety yields but the magnitude of the differences was small. The earlier maturing varieties, Marietta and Commercial, produced the highest average yield in the Region.

Factors other than yield may be of greater importance in selection of timothy varieties. Time of maturity, leafiness, and disease resistance may be cited as examples.

Multiplication and Testing of Strains

The second objective of Project NE-10 involves the multiplication and testing of promising strains of several forage crops. The purpose of objective 2 is to determine which strains on the basis of yield and other characteristics should be released and to determine their range of adaptation. The results of these tests are given below.

Birdsfoot trefoil: The New York Station has increased seed of four new strains of birdsfoot trefoil for testing. In addition, the Pennsylvania Experiment Station has produced sufficient polycross seed from 30 clones selected from Empire and 22 clones selected from "European types" for a Uniform Regional Test.

The Pennsylvania polycross seed was seeded at two locations in Pennsylvania in 1952. Seed has also been sent by the Pennsylvania Experiment Station to the North Dakota Experiment Station for 1953 planting in a winter hardiness test.

Ladino Clover: Approximately 100 clones were established at the Maryland Station in 1950 and 1951 for the production of polycross seed for progeny tests. Seed yields have not been adequate for establishment of uniform tests in the Region.

Red Clover: The efforts to increase strains of red clover breeding material at New Jersey have been unsuccessful.

Alfalfa: One hundred alfalfa clones selected in the Northeast Region were sent to Nebraska for production of polycross seed and to obtain a wilt test. Seed was produced in 1950 and this seed was used to establish a uniform progeny test of 75 clones and six varieties at Pennsylvania, New York, New Jersey, and West Virginia. The U. S. Regional Pasture Research Laboratory established a space-planted nursery of progenies of the 100 clones. Connecticut is evaluating progenies of 20 of the clones.

Orchardgrass: Upon initiation of the NE-10 project, restricted polycross seed of the components of seven U. S. Regional Pasture Research Laboratory experimental orchardgrass synthetics was provided by the Laboratory for evaluation. Tests involving 52 entries of this material were seeded in Pennsylvania, New York, and Maryland in 1950.

Data have been summarized for each location and the Pennsylvania Station has made a combined analysis of the data from the two locations. The results indicate that the relative performance of both the early

and medium maturing orchardgrass strains was similar at the two locations. On the other hand, a significant varieties x locations interaction for the late maturing group indicates that the relative performance of certain strains was different for the two locations. More specifically, several components of synthetic No. 7 and the synthetics No. 5 and No. 7 were significantly higher yielding than the late check variety, S-143, at New York, whereas there was no significant difference among these strains at Pennsylvania.

The yield data of the restricted polycross components of each of the seven synthetics indicate that certain parental clones are rather low in combining ability. On the basis of these results and data on leaf diseases certain parental clones will be dropped and improved synthetics will be made using only those parental clones with highest combining ability.

In 1951, 150 superior clones were established in polycross nurseries at State College, Pennsylvania, for polycross seed production. Seed was harvested from these clones in 1952 and is available for progeny tests.

Bromegrass: Multiplication of polycross seed has been undertaken at Cornell. Tests have subsequently been established at New Hampshire, New York, and Pennsylvania (1950) and additionally in Maine, Vermont, and New Jersey in 1951 and 1952.

A number of experimental synthetic varieties produced from superior breeding material at Cornell were available for regional testing in 1950. Six of these varieties were planted in replicated tests at New Hampshire, Maryland, and West Virginia to determine performance, both when grown alone and in conjunction with alfalfa. Seven varieties were tested alone at Pennsylvania, and eight varieties were planted in two locations in New York, both alone and with alfalfa.

Results obtained from the various stations in 1951 and 1952 indicate superiority of some of the varieties for disease resistance, production of aftermath, and total-season production. The trials are improtant not only for the evaluation of these specific varieties, but for gaining valuable information and experience for selection.

General Statements

The following general statements regarding applications of data resulting from NE-10 activities may be advanced:

Northeast Region recommended inclusion of Pennscott red clover into the National Foundation Seeds Stocks Project. This was subsequently accomplished during 1952.

The cooperative efforts of the Region were also instrumental in acceptance of Narragansett alfalfa into the National Foundation Seed Stocks Project.

Results of the regional tests have served to delineate adaptation limits within the Region for Buffalo and Williamsburg alfalfa.

The superiority of the "southern-type" bromegrass varieties over the northern type have been clearly demonstrated.

The Breeder's Seed Ladino (F.C. 23,608) has stimulated attention throughout the Region and action may be taken for a seed production program.

PASTURE RESEARCH AT STATE STATIONS

STORRS (CONNECTICUT)

Title: ALFALFA EXPERIMENTS

Leaders: B. A. Brown, R. I. Munsell, and E. J. Rubins

(a) Fertilization: With some crops socium can effectively replace some of the potassium. The first year results indicated that this substitution will not be successful for alfalfa.

On twelve farms, including seven soil types, neither the yield nor the nitrogen content of alfalfa were increased by applying one pound per acre of sodium molybdate.

(b) Varieties: In the test seeded in 1947, on land never planted with alfalfa, very marked reductions in stands occurred in 1952 with all non-wilt resistant varieties. Atlantic, Common, DuPuits, Meeker Baltic, and Ontario Variegated had the greatest decreases in stands. As a result, DuPuits, which had the highest yields through 1951, produced the least in 1952.

The test seeded in 1949 has not yet shown great differences in either stands or yields. However, Talent and Viking have the lowest average yields among the twenty-three varieties.

Title: THE MAINTENANCE AND IMPROVEMENT OF PASTURES

Leaders: B. A. Brown and R. I. Munsell

(a) The Adaptability of Varieties and Species of Grasses and Clovers for Pastures

Ladino Clover Fertilization: In the third harvest year, a Ladino clover-orchardgrass seeding, cut four times when about 10 inches high, responded to various soil treatments as follows (all yields on a dry matter basis):

Lime: Before liming, the soil was low in calcium and had a pH of 5.5. Under adequate potassium fertilization, the application of dolomitic limestone at 4 tons increased yields 13 per cent above limestone at 2 tons. Reducing the limestone to one ton decreased the prevalence of clover and the yields.

Phosphorus: For the third successive year, all of the eight raw rock phosphate treatments produced less than the lowest of seven superphosphate (46 per cent) applications and averaged 17 per cent less. The Ca meta-, K meta- and fused tricalcium phosphates were as effective as the super-phosphate.

Potassium: Supplying K_2O at 60 pounds after the second cutting each year has maintained less clover and a lower yield than larger amounts. The second increment of 60 pounds increased the yield 18 per cent, the third 19 per cent, and the fourth 5 per cent, or a total increase of 48 per cent.

Adding 30 pounds of K_2O after each cutting resulted in 10 per cent lower yields than 60 pounds, but in about the same production as 120 pounds in a single application after the second cutting.

There is very little Ladino clover remaining on plots given K_2O at 360 pounds before seeding and none afterward, but the preseeding 720 pound treatment is still maintaining good stands of clover and large yields in spite of the very high removals of potassium in the herbage.

Single applications of K_2O at 180 pounds were more effective when added after the first or second cutting than following the third or fourth harvest.

Nitrogen: Nitrogenous fertilizers after the second cutting increased the third harvest markedly and the annual yield slightly.

Title: THE USE OF HERBICIDES IN FORAGE CROP MANAGEMENT

Leaders: R. A. Peters and B. A. Brown

(a) Common Chickweed Control in Alfalfa: Of the chemicals tested for chickweed control, isopropyl N-(3-chlorophenyl)carbamate (CIPC) and the ammonium salt of dinitro-ortho-secondary-butylphenol (DN) were the most effective. In most cases, control or kill was obtained with 2 pounds active ingredient per acre of CIPC or one to two pounds of DN on either seedling or established stands. The CIPC was markedly injurious to grasses in mixtures with alfalfa.

Chickweed was found capable of producing over 24,000 seeds per square foot in less than a year. Since these seeds rapidly reinfest a treated area as soon as the residual effect of the herbicides is gone, a single herbicide application will not control chickweed for an entire season.

(b) Control of Quackgrass with Sodium Trichloroacetate: Treatments were made on six-year old alfalfa which had become heavily infested with quackgrass. Without exception, the effectiveness of the TCA was greater after plowing. Treatments made in November 1951, April, May, and July 1952 included application of the entire rate and also a split application in which half of rates of 10, 20, and 40 pounds acid equivalent were applied several weeks later. The split application at the 10 and 20 pound rate was more effective when split between November and April but on the other dates there was no advantage. The evidence indicates that TCA was most effective if applied in the spring as new growth of rhizomes was starting.

(c) Use of Chemicals in Pasture Renovation: The use of chemicals to kill existing vegetation prior to seeding offers promise in fields which cannot be readily tilled. In December 1951, several materials were applied on an undisturbed sod of Danthonia, Agrostis and Anthoxanthum spp.

CMU, 3-(p-chlorophenyl-1,1-dimethylurea), and CIPC, isopropyl N-(4-chlorophenyl)carbamate, were the only effective materials. All rates of these chemicals including the low rate of 50 pounds per acre completely killed the sod.

Broadcast seedlings of birdsfoot trefoil and of Ladino clover on April 7, 1952, did not become established because of residual toxicity. Seedings made on June 3, 1952, became established on the CIPC plots but not on the CMU plots.

The experiment is being repeated including several other chemicals.

(d) Weed Control in New Seedings of Forage by Post-Emergent Application of Herbicides: Seedings of Ladino clover alone, alfalfa alone, Ladino clover-orchardgrass mixture and alfalfa-timothy mixture are to be treated both after seedings in August without a companion crop and in April in an oats companion crop.

The August 1952 seedings were treated on September 9, 1952, at about the third true leaf stage. The Alkanolamine salt of dinitro-ortho-secondary-butylphenol at rates of 2, 4, and 8 pounds per acre gave the best weed control of the materials used but there was considerable contact injury of the forage species. The seedling grass stand was severely reduced while the alfalfa and Ladino clover recovered by freezing time.

2,4-D, amine salt, caused severe stand reduction of the legumes at all rates--1/8, 1/4, and 1/2 pound per acre. Ladino clover was injured less than alfalfa. Under the conditions of the test, neither isopropyl N-(4-chlorophenyl)carbamate, CIPC, at rates of 2, 4, and 8 pounds per acre nor sodium TCA at rates of 5, 10, and 15 pounds per acre had marked herbicidal effect. A prolonged dry spell following application may have been a factor in this response.

DELAWARE

Title: FERTILITY REQUIREMENTS OF LEGUME AND GRASS-LEGUME MIXTURES

Leaders: W. H. Mitchell and L. J. Cotnoir, Jr.

Unfavorable growing conditions during the late summer and fall of 1951 caused a complete failure of the Ladino clover. An attempt is being made to re-establish Ladino clover in this area without seriously disturbing the plots.

Work on this project continued during 1952 at the Georgetown sub-station. The experimental technique and treatments were much the same as those at Newark with the exceptions that the Georgetown study was conducted on a loamy sand soil and involved split applications of nitrogen in addition to phosphorus and potash. In general the largest yields were obtained when nitrogen was applied. Applications of 50, 100, and 200 pounds of nitrogen, with 200 pounds each of P_2O_5 and K_2O, gave yield increases of 44, 59, and 74 per cent, respectively, over the unfertilized plots. Two hundred pounds of P_2O_5 and K_2O applied without nitrogen produced a 30 per cent increase in yield over the unfertilized plots. The split applications of nitrogen did not increase yields over the single spring application, but the summer distribution of growth was improved. When applied in a single spring application, 0, 50, 100, and 200 pounds of nitrogen produced an estimated 53, 42, 26, and 18 per cent clover stand, respectively. When this nitrogen was applied one-half in March and one-half in July, the resulting stand contained 54, 47, 39, and 35 per cent Ladino clover, respectively. There appears to be less reduction in the amount of Ladino clover, as a result of nitrogen treatments, on the Norfolk loamy sand at Georgetown than on the Sassafras silt loam at Newark.

Title: SUPPLEMENTAL IRRIGATION AND FERTILIZATION OF PASTURES

Leaders: W. H. Mitchell and L. J. Cotnoir, Jr.

During 1952 exploratory work in pasture irrigation was conducted at the University of Delaware substation at Georgetown on a Norfolk loamy sand. Supplemental irrigation was provided by a March type oscillating sprinkler using water from a driven well. Pasture mixtures of Ladino clover-orchardgrass and Ladino clover-bromegrass were used in this study. One inch of water was applied during each week in which total rainfall for a 24-hour period was less than one inch.

Under irrigation from June 13 to October 10, the Ladino clover-bromegrass produced 1903 pounds more forage on a dry weight basis than the non-irrigated plots. Ladino clover-orchardgrass plots produced an increase of 1100 pounds as a result of irrigation during the same period, the difference being due to the greater production of orchardgrass under normal rainfall in southern Delaware. Irrigation tended to increase the growth of Ladino clover in relation to associated grasses. The estimated stand of clover in an orchardgrass-Ladino clover sod was 26, 30, and 48 per cent, respectively, for three successive cuttings without irrigation, as compared with values of 46, 54, and 64 per cent under irrigation.

MAINE

Title: BREEDING AND EVALUATION OF FORAGE CROPS

Leaders: L. H. Taylor and C. H. Moran

There was adequate snow cover during the winter of 1951-52 at both Orono and Presque Isle and no appreciable winter injury occurred in the observational forage nurseries at either location. The summer drouth reduced all second crop yields except those of alfalfa, which were apparently able to make a near normal growth.

Replicated randomized complete block trials of both alfalfa and bromegrass were planted in June 1952 at Orono. We hope that these seedings will survive the vicissitudes of the severe drouth and a winter without snow cover so that we can begin to secure yield data from these tests in 1953.

Replicated trials of from 5 to 10 forage associations were established on twelve farms in various parts of Maine. This is a new type of trial with us and represents an effort to secure more nearly statewide coverage with our forage program. In these trials, we plan to observe the performance of forage species and combinations under farm conditions in Maine. In certain cases, we will also cut out sample strips and take forage yields. We plan to continue this type of trial for several years and to determine their value from both a research and demonstration standpoint.

Title: MANAGEMENT PRACTICES AS THEY AFFECT THE PRODUCTIVITY AND PERSISTENCE OF LADINO CLOVER-GRASS ASSOCIATIONS

Leaders: C. H. Moran and L. H. Taylor

A split plot experiment was established at Orono in 1952 in which Ladino clover-grass associations are to be compared for yield and survival under various cutting treatments. The plots of this experiment consist of Ladino clover in associations with timothy, orchardgrass, smooth bromegrass and Kentucky bluegrass. Each whole plot is divided into two series, (a) where the last cutting will be made not later than mid-September, and (b) where the last cutting will be made in early to mid-October. Within each series the following cutting treatments will be practiced:

1. Cut every 21 days beginning on May 15
2. Cut every 28 days beginning on May 15
3. First crop cut at early head stage - aftermath cut at 21-day intervals
4. First crop cut at early head stage - aftermath cut at 28-day intervals

As the seeding of this trial was followed by a very severe drouth, supplemental irrigation was used to insure stand establishment.

Title: SOIL FERTILITY IN RELATION TO FORAGE CROPS IN MAINE

Leaders: C. H. Moran, L. H. Taylor, and P. N. Carpenter

In the experiments on the effects of soil fertility levels on the yield and persistence of Ladino clover in association with timothy, the first forage yield data were secured from tests established in 1951. At two locations in central Maine and one in Aroostook County, there were no significant yield differences due to fertilizer treatment. The high level of random variation that was present may have been due in part to the severe drouth. Yields of the second cutting in central Maine were very low for this reason.

The first yield data were also secured from a test of the effects of levels of rock phosphate application on performance of a Ladino clover-bromegrass association. This test was established at Monmouth, Maine, in 1951. The yield data showed no significant difference in yield due to level of rock phosphate application or to 50 pounds per acre of nitrogen vs. no nitrogen which was applied as a split plot treatment. There was a highly significant interaction between level of rock phosphate and nitrogen vs. no nitrogen. This interaction apparently resulted from a yield response from nitrogen at intermediate levels of rock phosphate while there was no response at either lower or higher levels. More data will be needed before a valid interpretation of this interaction can be made.

Title: PASTURE IRRIGATION

Leader: R. A. Struchtemeyer

During the 1952 growing season there certainly was an opportunity to show the benefits of supplemental irrigation on pasture and hay lands since about 0.5 of an inch of rain fell from the middle of June to the first of August. No experiments on pasture and hay land irrigation were planned for 1952. However, some pipe was purchased for watering the University pastures and on a controlled demonstration of eight acres the dry matter production was about 1500 pounds per acre more on the irrigated portion than on the nonirrigated portion.

Checking the milk production records of the herd, it was very apparent when the cows were on the irrigated pastures. Production increased when good green feed was available.

MARYLAND

Title: ORCHARDGRASS BREEDING

Leader: T. S. Ronningen

A polycross progeny test of selected clones from the polycross nursery, briefly described in the 1951 Annual Report, page 6, was established in the fall of 1952. The entries included 24 in maturity Group I, 32 in Group II, 13 in Group III, and 20 in Group IV. Pasture Laboratory Synthetics IV through VII, Commercial, Beltsville, and S-143 were included as checks. Substantial differences in seedling vigor were noted in the fall of 1952.

Title: IMPROVEMENT OF RED CLOVER ADAPTED TO MARYLAND

Leaders: A. Morris Decker, Jr. and Conrad H. Liden

Work on the development of red clover lines resistant to southern anthracnose (Colletotricum trifolii) is being continued during the 1952-53 season. Some of these lines are now in their fourth generation of selection. The progress of work thus far will be evaluated during the 1953-54 season. These selected lines will be compared with Kenland and several of the more important local strains. They will be compared on the basis of resistance to southern anthracnose, seed and forage production, and other agronomic characteristics such as hay type, longevity of stand, vigor, and general resistance to powdery mildew (Erysiphe polygoni) and other foliar diseases. Resistance to southern anthracnose will be evaluated both in the greenhouse and in the field. Because of a limited amount of seed all field tests will be made in replicated row plantings in place of solid seedings.

Title: DEVELOPMENT AND MAINTENANCE OF SUPERIOR LADINO CLOVER BREEDING MATERIALS

Leader: T. S. Ronningen

A limited amount of breeding work has been initiated over the past several years. A regional polycross nursery with 37 entries was established partly in 1950 and partly in 1951. Because seed set was very low, the clones have been established in pots in the greenhouse where it is hoped sufficient seed can be produced for regional testing of polycross progenies of these clones.

A nursery of 22 clones selected from an observation nursery and replicated five times was established in 1952.

Approximately 90 clones were saved from a three-year-old evaluation nursery at Beltsville in the fall of 1952. These will be put into a replicated clonal nursery at College Park in 1953.

Title: VARIETY AND STRAIN TESTING OF FORAGE LEGUMES AND GRASSES

Leaders: T. S. Ronningen and A. Morris Decker, Jr.

Variety and strain tests have been continued for a number of species of grasses and legumes at College Park and in other parts of the state. Conclusions for the various species are based on accumulative results and observations.

Alfalfa: Williamsburg appears to be more productive and long-lived than other varieties in all but the western part of the state. Buffalo, a dependable variety in all tests, has been as productive and persistent as Williamsburg in western Maryland. Atlantic has compared favorably with Buffalo in most trials. Narragansett appears promising. This variety seems to be superior to others under conditions of imperfect drainage. Most northern alfalfas have been inferior in performance.

Red Clover: Kenland appears to be superior to other varieties in most areas of western Maryland. However, Bayne, Shawn, Pennscott, and Stevens were all superior to Kenland in the only harvest made at Uniontown, in nothern Maryland. These same varieties and strains along with Reinholdt, Messix, Pioneer, Oland, and Sanford strains were superior to Kenland on the Eastern Shore of Maryland. Many of these local strains are in very limited seed supply, and collectively they do not furnish much of the overall seed demands. During the 1951-52 season Kenland red clover stands were almost completely eliminated from plantings on the Eastern Shore. However, in some areas good results have been obtained from Kenland seedings in previous years.

Ladino Clover: Breeder's Ladino clover (F.C. 23,608) has been superior in yield and competitive ability with orchardgrass when compared with other domestic and foreign lots. Although no stands were satisfactory following the fall and winter of 1951-52, a greater number of plants of Breeder's Ladino clover survived in mass-seeded plots than of other strains tested. A strain comparison test with 15 entries seeded alone and with orchardgrass was begun in the spring of 1952. They include mostly western sources of certified Ladino clover and two separate Syn 1 generations, and one Syn 2 generation of Breeder's Ladino (F.C. 23,608).

Annual Lespedeza: Climax and Rowan have been superior in yield and quality in two years of testing. Iowa 6 looked promising in 1952, the only year it has been included so far.

Birdsfoot Trefoil: All varieties have been unproductive. There has been some evidence that the species may have a place in the higher altitudes of western Maryland.

Orchardgrass: Commercial orchardgrass has been superior to Beltsville in total yields, but Beltsville has been superior in resistance to foliar disease and insect damage, leafiness, and aftermath growth. Late maturing strains have been generally unsatisfactory, especially for pasture. Several Pasture Laboratory Synthetics appear promising.

Tall Oatgrass: Tualatin and Commercial tall oatgrass have been productive both alone and in mixtures. Tualatin has proved to be substantially more resistant to leaf rust and has been more leafy than Commercial.

Smooth Bromegrass: Southern bromegrass varieties continue to be higher yielding and more persistent than northern varieties. All varieties are highly susceptible to Rhizoctonia leaf blight which is a major factor in reducing midsummer production.

Sudan Grass and Pearl Millet: One of the Southern regional uniform Sudan grass and Pearl millet strain tests was conducted at the Tobacco Experimental Farm in southern Maryland. All plots of the ten Sudan grass and seven Pearl millet strains were harvested three times at a pasture stage of growth. In general the Pearl millet strains were superior in dry matter production to the Sudan grass entries and they were relatively free of foliar disease. Several hybrids originating from the Coastal Plains station at Tifton, Georgia, were very promising. Tift Sudan grass has been consistently superior to Commercial, Piper, and several other entries both in yield and freedom from foliar diseases in this and previous trials. Sweet Sudan grass has proved to be more palatable to livestock than other varieties of Sudan grass tested, but has not been as disease-free or productive as Tift.

Title: EVALUATION OF GRASS SPECIES AND STRAINS FOR USE WITH ALFALFA FOR HAY

Leaders: T. S. Ronningen and Nevin Brandenburg

Strains of bromegrass, tall oatgrass, orchardgrass, and timothy are being tested for hay production when grown alone and in association with alfalfa. A test including eight bromegrass strains, 3 strains of orchardgrass, 2 varieties of tall oatgrass, and commercial timothy was initiated in the fall of 1950 at Breathedsville in the northwestern part of the state. A similar trial containing a larger number of combinations was started in the spring of 1952 at College Park.

The following results were obtained from the yields during two seasons at Breathedsville. Stands of bromegrass and timothy were considerably reduced the second year. The orchardgrass-alfalfa and tall oatgrass-alfalfa mixtures produced about 3/4 ton more hay per acre than alfalfa alone. Bromegrass-alfalfa and timothy-alfalfa mixtures produced little more herbage than alfalfa alone especially in 1952. Cornell Syn. G and Syn. H gave the highest yields of the bromegrass varieties; Syn. F and Canadian Commercial were the least productive. Yields of Commercial tall oatgrass were slightly higher than those of Tualatin. Medium Synthetic orchardgrass from the Pasture Laboratory, in association with alfalfa and grown alone, was superior to Late Synthetic and Commercial in 1952. Differences among the orchardgrass strains were not significant in 1951.

Title: SEEDING EFFICIENCY STUDIES OF RED CLOVER ON SMALL GRAINS

Leader: A. W. Burger

This study was started in the spring of 1951 and was continued through the 1952 growing season and involves two seeding methods--broadcast and disk-drill, two seeding rates--8 pounds and 4 pounds, and two seeding dates--early February and early April. The disk-drill method of seeding involves a simple adaptation of the conventional disk-grain drill. The grass seeding compartment seed tubes are made to feed the seed flow through the boot and into the one-half inch deep disk cuts.

February seedings were superior to April seedings. Satisfactory stands resulted from the four pound rate of seeding in February using the disk-drill method. At either the four pound or eight pound rate of seeding the disk-drill method was superior to the broadcast method. To get satisfactory stands from the April seeding, eight pounds of seed using the disk-drill method were required. Thus it appears that (1) February seedings are better than April seedings and for that reason, April seedings should be at a heavier rate, and (2) by breaking and stirring the soil surface crusts, greater numbers of red clover seeds will produce plants.

Title: PASTURE RENOVATION STUDIES

Leaders: A. W. Burger, T. S. Ronningen, and A. O. Kuhn

Renovation studies to compare various grass-legume mixtures and disking vs. shallow plowing for seedbed preparation as well as fall vs. spring establishment have been continued (1951 Annual Report, page 40). The four most promising tall growing grass-legume mixtures are (1) orchardgrass and Ladino clover; (2) orchardgrass, Ladino clover, and red clover; (3) orchardgrass, Ladino clover, red clover, and alfalfa; and (4) tall fescue, Ladino clover, red clover, and alfalfa. The addition of red clover and alfalfa to the orchardgrass-Ladino clover mixtures increased the dry matter yields. This effect has been consistently reported for the 1949, 1950, 1951, and 1952 harvest years on all of the plots being studied regardless of the time and method of establishment. Much of the legume population in these mixtures was lost during the winter and spring preceding the 1952 harvest season.

Fall establishment by disking and spring establishment by shallow plowing have been superior treatments for seedbed preparation. Fall seeded mixtures generally have been showing higher dry matter production than spring seeded mixtures. This project will be terminated and a report completed by June 30, 1953.

Title: PHENOLOGICAL STUDIES IN FORAGES

Leaders: A Morris Decker, Jr., T. S. Ronningen, and H. C. S. Thom, United States Weather Bureau, Cooperating

During the past year soil and air temperatures were obtained at various levels within a number of plots from the NE-10 Strain and Variety test at the University of Maryland Plant Research Farm (1950 Annual Report, page 50). The maximum, minimum, and daily average temperatures of the soil and air at various levels were quite different. This corroborates results reported by V. G. Sprague (1950 Annual Report, page 36) and previous work at this Station (1951 Annual Report, page 42).

The study of temperature and early spring growth was continued. The following formula was used to relate temperature and early spring growth rates: $G = \sum_{1}^{N} F_T \ (T - B)$ where G is the temperature-growth index, F_T the frequency of temperature occurrence, T the temperature at each two hour period, and B the base temperature used.

Weekly temperature-growth indices obtained with this formula were plotted against weekly growth rates of the various forage species being studied (leaf elongation was used as a criterion of growth). High correlations between leaf elongation and temperature-growth indices were obtained with all species except Ladino clover. In this species, considerable disease and winter injury resulted in a lowered, more erratic growth which accounted for this poor relationship. However, when these same data were accumulated from week to week, as is often done when studying temperature-growth relationships, high correlations were obtained whether they actually existed or not. As this problem was studied further, it was found that good agreement could even be obtained between two groups of numbers chosen from a table of random numbers and accumulated in this manner. These numbers were not related, but a high correlation was obtained using this method of evaluation. This emphasizes the need of exercising care in presenting data in this way, and points out the need for more information along these lines. The results obtained in 1952 were consistent with those obtained in the 1951 study.

The heaving study initiated in the fall of 1951 is being continued during the 1952-53 winter period. No difference has been found among peg diameters. However, the depth at which each peg is placed in the soil does appear important. As a result only the one-half inch pegs placed at depths of 4, 6, 8, and 12 inches are being used in the current season. The frequency of freezing and thawing, duration and extent of frost penetration, and the amount and type of plant cover are all factors that are being considered in this problem.

Title: FERTILIZATION OF PERMANENT BLUEGRASS PASTURE

Leader: A. W. Burger

The dry matter production from bluegrass pasture under different intensities of nitrogen fertilization was measured after adequate liming and application of 700 pounds of 0-12-12 per acre on permanent pasture. Thirteen treatments involving ammonium sulphate applications ranging from 100 pounds to 2000 pounds applied in one and in as many as five top-dressings on permanent pasture are being used in the test which was started in March 1952. The dry matter yields have ranged from 2.14 to 4.69 tons per acre on the various treatments. It appears that much benefit can come from complete fertilization on many permanent pastures in Maryland.

Title: GRASS AND LEGUME COMBINATIONS FOR BEEF PRODUCTION

Leader: A. W. Burger

The 1951 results of the beef and dry matter production of five pasture mixtures are given in the table below:

MIXTURE	BEEF PRODUCTION (pounds of beef per acre)	DRY MATTER PRODUCTION Tons per acre	
		Cages	Strips
1 Orchardgrass-Ladino clover*	382	1.54	1.54
2 Tall Fescue-Ladino clover*	370	1.74	2.15
3 Kentucky bluegrass-timothy-white clover	375	1.29	1.30
4 Orchardgrass-lespedeza	303	1.60	1.46
5 Tall Fescue-lespedeza	246	.96	.92

* Much of the Ladino clover in these two mixtures was killed during the winter and spring preceding the 1952 grazing year. Clover losses appeared to be due to the weakening of the plants by severe drought conditions in the fall of 1951 followed by heaving and stem rot during the winter and spring preceding the 1952 grazing season.

Title: CONTROL OF WEEDS IN LEGUMES

Leaders: L. F. Morris, Jr., and A. O. Kuhn

Primary work during the past year was concerned with the control of chickweed in alfalfa. A mixture of timothy and alfalfa was seeded in August 1951. Five chemicals, each at three rates, were applied during October, January, March, and April to study their effectiveness in the control of chickweed. The ammonia and alkanolamine salts of DNOSBP proved effective in reducing competition from chickweed when applied at 1, 2, and 4 pounds per acre on all of the above dates. CIPC applied

at 4, 8, and 16 pounds per acre proved effective on all dates in killing chickweed and in preventing regrowth of this weed. The CIPC also killed all timothy and volunteer barley. Rates were heavier than appeared to be necessary for chickweed control. IPC used at 4, 8, and 16 pounds per acre gave results similar to that obtained with CIPC, except that it proved more injurious to alfalfa when applied in October. Calcium salt of TCA applied at rates of 8, 16, and 32 pounds per acre gave no control of chickweed.

MASSACHUSETTS

Title: YIELD AND VEGETATIVE AND CHEMICAL COMPOSITION OF FORAGE CROPS AS AFFECTED BY SOIL TREATMENT

Leaders: J. L. Parsons, M. Drake, and W. G. Colby

Field studies were conducted on Ladino clover, orchardgrass, smooth bromegrass, and timothy (1949 Annual Report, page 58). Each species was planted in a pure stand to determine its requirements with respect to phosphorus and potassium.

Increases of 30 to 80 per cent in hay production were obtained when adequate potassium was applied. Split applications of potassium fertilizer were used instead of single large applications. Although the percentage phosphorus in the plant material increased with added increments of P_2O_5, there was no appreciable yield response by most species above the lowest rate.

The efficiency of phosphorus removal expressed as percentage of applied P_2O_5 is of special interest. What is the explanation for the lack of response by the grasses to increments of applied P_2O_5? The grasses on the average removed 164 per cent of applied P_2O_5 on the lowest P_2O_5 treatment, whereas Ladino clover, which produced less dry matter, utilized 115 per cent of applied P_2O_5. The percentage recovery of applied P_2O_5 on low phosphated plots for the grasses was 183, 170, and 138 for orchardgrass, bromegrass, and timothy, respectively. In view of the high phosphorus-fixing capacity of this soil, it is evident that, under the system of management used with high nitrogen and potash fertilization, the grasses used were able to utilize a certain amount of this fixed phosphorus. By the end of the third crop year, although there was no decrease of hay production, there was a decrease in phosphorus content of the plant material on the low phosphate plots. Therefore, on this soil the application of 50 pounds available P_2O_5 per acre may not be sufficient to supply the phosphorus requirements in high yields of timothy, orchardgrass, and smooth bromegrass for more than three years.

Although liberal amounts of potash fertilizer were applied to the grasses there was nearly complete removal of applied potassium (79 to 94 per cent). This points up the fact that it is not possible to

increase the reserves of soil potassium when producing large yields of the forage grasses, smooth bromegrass, orchardgrass, or timothy on this and similar soils.

Competition for potassium between desirable forage species and undesirable weedy species has a pronounced influence on the longevity of the stand. Ladino clover stands on the low potash plots showed reduction in stand from 90 to 45 per cent from October 1950 (end of first harvest year) to the spring of 1951; to less than 15 per cent of the total vegetation by the end of 1951 (second crop year) and to less than 5 per cent by the spring of 1952 (third crop year). For the same periods on the high potash plots the Ladino clover decreased from over 90 per cent in October 1950 (end of first crop year) to 81 per cent in the spring of 1951; to 68 per cent by the fall of 1951 (second crop year) and to 30 per cent by the spring of 1952.

The most pertinent facts shown by these and other data are: (a) Ladino clover maintains itself well during the first crop year if adequately fertilized at seeding time, but the potassium content drops rapidly, and the Ladino clover plants go out after the readily available potassium has been depleted; (b) with inadequate potassium the Ladino clover was low in potassium and was unable to survive the winter with sufficient vigor to compete with bentgrass which made a rapid growth early in the season; and (c) with adequate potash fertilization (150 to 200 pounds K_2O per acre) Ladino clover stands were maintained without serious decline until the third year.

During the spring of 1952 a marked decrease in the stand of Ladino clover occurred on the highest potash plots. This decrease may be attributed to the rapid growth of the weedy grasses, bent and Kentucky bluegrass, during the cool spring months. It is thus evident that even with high potash fertilization the ingress and dominance by the weedy grasses cannot be entirely prevented unless they are completely eradicated before seeding the Ladino clover.

Title: POTASSIUM COMPETITION IN GRASS-LEGUME ASSOCIATIONS AS A FUNCTION OF ROOT CATION EXCHANGE CAPACITY

Leaders: Mack Drake, Bryce Gray, and W. G. Colby

Ladino clover, smooth bromegrass, Kentucky bluegrass, and bentgrass were grown in greenhouse pots to determine the relative uptake of potassium by the species when grown separately, and to study the competition for potassium when Ladino clover was grown in association with each of the three grasses. The purpose was to determine to what extent the theory of differential cation uptake by plants of different root cation exchange capacity can explain the disappearance of legumes from pasture mixtures as a result of plant competition for potassium. Potassium uptake by plant species at low levels of soil potassium was closely correlated with root cation exchange capacity. The relative potassium compatibility was smooth bromegrass (best), Kentucky bluegrass (intermediate) and bentgrass (poorest). Because of the strong attraction and high uptake of potassium by roots of bentgrass, it was impossible with practical potassium fertilization to maintain an adequate potassium supply for the associated Ladino clover.

NEW HAMPSHIRE

Title: BREEDING AND VARIETY TESTING WITH SMOOTH BROMEGRASS, LADINO CLOVER, AND RED CLOVER

Leaders: G. M. Dunn and L. J. Higgins

A source nursery of 54 varieties and strains of bromegrass was established in 1952. The major objective will be to try to locate resistance to the brown leafspot organism, Pyrenophora bromi which appears to be the predominant leaf disease in New Hampshire. Distinct differences were noted between and within strains in resistance to this disease in 1952. Several hundred plants were selfed, and the inbred progeny will be examined for reaction to this disease. Other species of Bromus are being collected, and will be examined for desirable characters and to determine if they will cross with Bromus inermis.

A test of 8 southern and 2 northern types of bromegrass was established in 1952 with and without Ladino clover to obtain information on varietal yields and the component yields of the mixture. Also, in cooperation with Cornell University, a test was planted of the second synthetic generation of the New York synthetics (1950 Annual Report, page 50).

A source nursery of Ladino clover will be planted in 1953.

During the past year, new breeder's red clover seed was obtained by hand pollination in the greenhouse. The parent plants had been isolated in the greenhouse for over a year.

Some seed was multiplied during the past summer, and it will be used in replicated yield trials with other varieties this coming summer.

Title: LADINO CLOVER AND BIRDSFOOT TREFOIL VARIETY TRIALS

Leaders: P. T. Blood, G. M. Dunn, and L. J. Higgins

Yields were obtained for the second year on seven California and Oregon strains of Ladino clover (1951 Annual Report, page 49). Commercial Ladino clover and F.C. 23,608 were also included in this trial.

Highest yields were obtained in 1952 for a certified Oregon strain and for F.C. 23,608. The yields for these two strains were 4206 and 4137 pounds dry matter per acre, respectively. The California strains were lowest in yield.

This test was seeded in 1949. All strains have good stands, with little or no evidence of winter killing for the past season.

The birdsfoot trefoil test was also seeded in 1949, in a comparison of Empire, Viking, Narrow Leaf, one Italian strain, and several Empire selections obtained from Cornell University. Poor stands were obtained when seeded; very little improvement of stand has occurred. Yields in 1952 were low, with Empire and a selection from Empire giving highest yields.

Title: ALFALFA VARIETY TRIAL

Leaders: P. T. Blood, G. M. Dunn, and L. J. Higgins

In 1951 and 1952 yields were taken of the following varieties: Ranger, Buffalo, Narragansett, Grimm, Ontario, Atlantic, New Hampshire bromegrass, and New Hampshire bromegrass with Ranger.

Narragansett alfalfa again produced the highest yield, 4860 pounds dry matter per acre, and Grimm the lowest, 2867 pounds per acre. The low yield of Grimm may be largely because of the poor stand obtained in 1950. Yields of the varieties Atlantic, Buffalo, and Ontario were 4191, 3934, and 3503 pounds per acre, respectively. The combination of New Hampshire bromegrass with Ranger yielded significantly more than any alfalfa variety alone.

Except for Grimm, stands are generally good in the alfalfa varieties with no evidence at present of bacterial wilt.

Title: YIELD TRIALS OF BROMEGRASS SYNTHETICS AND POLYCROSS STRAINS

Leaders: P. T. Blood, G. M. Dunn, and L. J. Higgins

The synthetic trial consists of six New York synthetics plus two checks, Lincoln and Canadian Commercial. Yield data have been taken for 1951 and 1952 (1951 Annual Report, page 50).

One of the synthetics, syn B, was superior for yield for both years, exceeding the better check, Lincoln, by approximately 400 pounds dry matter per acre in 1951 and 1100 pounds in 1952. The yields of syn B and Lincoln, in pounds dry matter per acre for 1952, were 7137 and 6054, respectively. Two other synthetics exceeded Lincoln by about 600 pounds per acre in 1952.

Yield data for two seasons have also been obtained for twenty-five polycross progenies. Yields for the polycrosses were consistently lower than for the synthetics, but a few polycross strains produced yields comparable to the check varieties.

Title: THE INFLUENCE OF SOIL TYPE ON THE PERSISTENCE OF PERENNIAL LEGUMES

Leaders: Louis T. Kardos and Paul T. Blood

The four perennial legumes (alfalfa, trefoil, Ladino clover, and perennial red clover) were reseeded on the droughty Stratham gravelly loam in August 1951 (1951 Annual Report, page 50). Good stands were secured and the first cutting in 1952 showed total yields of legume to be in the order: perennial red clover > Ladino clover > alfalfa > trefoil. This first cutting was followed by a 3 week drought in which only 0.45 inches of rainfall occurred. As a result, the Ladino

clover made a very poor recovery and the trefoil was not much better. The alfalfa and red clover, however, grew fairly well during the drought.

Later in August, when the rains came, the Ladino clover responded tremendously and in the second cutting on August 26 it outyielded the alfalfa and red clover plots. The trefoil remained a poor fourth.

On the Paxton loam soil all legume stands continued to deteriorate. Severe potash deficiency symptoms were evident on the alfalfa and Ladino clover, and boron deficiency symptoms also appeared on the alfalfa during the dry period in July. It appears that in the Paxton soil, unlike in the Stratham soil, the dominant inherent characteristic limiting persistence of the legumes is chemical rather than physical.

Title: THE FERTILITY NEEDS OF LADINO CLOVER

Leaders: Louis T. Kardos and Paul T. Blood

The 1952 yield responses of Ladino clover to the lime and potash variables were similar to those found in 1951, with potash more critical than lime (1951 Annual Report, page 51). The principal difference from the 1951 data was that the split application of potash (50 pounds K_2O in the spring and 50 pounds K_2O after the first cutting) resulted in much better yields of Ladino clover than the spring application of 100 pounds of K_2O. In 1951, there was relatively little difference between these two treatments.

Title: EFFECT OF SOIL TYPE AND MINERAL ADDITIONS ON THE MINERAL CONTENT OF CLOVER AND TIMOTHY

Leaders: G. P. Percival and D. Josselyn with the cooperation of K. C. Beeson, U. S. Plant Soil and Nutrition Laboratory, Ithaca, New York

Yields of hay and its timothy content were taken on plots on a Paxton soil in Center Strafford for the last year of the experiment. These plots had been treated with two levels of cobalt and with lime, nitrogen, and potassium as variables. These samples are being analyzed for cobalt, phosphorus, and manganese content.

The plots laid out on Paxton soil in Northwood, completely confounding the four factor interaction of species x lime x fertility x micro-elements were random sampled by species--timothy, Ladino clover, red clover, and bromegrass--for yield and chemical analysis. These samples are being analyzed. Soil samples were taken from the same random spots from which the yield was taken in order to determine the micro-element status of the soil.

Work is being continued in the greenhouse on the depressing effect of lime on oats. Greenhouse trials on several soils have shown that

applications of lime depressed the yield of oats. This year other soils are being tried and two rates of sulfur application are included in the experiment to determine their effect.

Title: THE EFFECT ON THE CAROTENE CONTENT OF GRASSES AND LEGUMES OF VARIOUS METHODS OF PRESERVATION

Leaders: G. P. Percival and D. Josselyn

Samples of timothy, Ladino clover, bromegrass, alsike clover, red clover, and alfalfa were stored as field-cured hay, mow-cured hay, and molasses silage and in an above-ground trench-type silo, sulfur dioxide treated and untreated, both packed and unpacked. Again the advantages of ensiling forage for the preservation of carotene were outstanding. The sulfur dioxide-packed silage showed the least amount of loss. The untreated packed was in second place, with molasses silage a close third.

This year the work is limited to a comparison of samples of red clover, timothy, bromegrass, and alfalfa, untreated and treated with 8 pounds of sodium bisulfite per ton of silage. Samples of some of the species were also stored in a sulfur dioxide treated silo at a nearby dairy farm.

Title: MAXIMUM USE OF ROUGHAGE IN FEEDING DAIRY CATTLE

Leaders: H. A. Keener, N. F. Colovos, and H. A. Davis

Work completed on this project since the last year (1951 Annual Report, page 53) continues to indicate the superiority of grass silage over hay made from the same field at the same time as a feed for yearling dairy heifers. When fed grass silage as the sole ration, the heifers gained approximately twice as much in body weight as those fed either field-cured or the mow cured hays. There was no difference in the gains made on the two types of hay.

Results from the use of sulfur dioxide as a silage preservative at this station have been favorable, but the method of application has discouraged the use of this product as a silage preservative. Along with several other experiment stations, a study is being made on the value of sodium bisulfite as a substitute for sulfur dioxide. Although conclusions cannot be drawn at this time, preliminary results appear to be favorable to the use of this material. Sodium bisulfite is very easily applied and silage preserved with it seems to be of excellent quality.

Title: THE RELATIONSHIP BETWEEN THE DIET OF DAIRY ANIMALS, THE DIGESTIBILITY AND UTILIZATION OF PROTEIN AND ENERGY, THE SYNTHESIS OF SOME OF THE B VITAMINS AND THE ACTIVITY OF THE FLORA OF THE DIGESTIVE TRACT

Leaders: N. F. Colovos, H. A. Keener, A. E. Teeri, and H. A. Davis

The work on the study of the nutritive evaluation of forage preserved by different methods (1951 Annual Report, page 52) was continued for the third year. The results of this study show that the silage far excelled mow-cured hay and field-cured hay in protein utilization when compared on the dry matter or digestible protein basis. This was in spite of the fact that the digestibility of the protein was higher in both the mow-cured and field-cured hays.

The study of the effect of pulverized limestone on the digestibility of the protein and the energy (1951 Annual Report, page 52) was completed. In the second year's work graded amounts of limestone were fed with the silage. As in the previous year, the digestibility of the protein was depressed when 100 grams of pulverized limestone per head per day or about 2 per cent of the ration on the dry matter basis was fed. It was also noted that limestone depressed the synthesis of thiamin. There was no effect on the digestibility of either protein or energy when 50 grams of limestone were fed.

The comparisons between silages preserved with sulfur dioxide and silages preserved with molasses, the forage of which was obtained from the same field, were completed. In both the oat silage and the timothy silage the digestibility of the protein of the sulfur dioxide-preserved silages was significantly higher. The digestibilities of the energy also were higher but not as significant as the protein. In this study it also was found that synthesis of thiamin by rumen micro-organisms was greatly increased when the ration was sulfur dioxide-preserved silage. A favoring but less pronounced action of sulfur dioxide on the synthesis of nicotinic acid also was noted.

Title: THE EFFECT OF THE MAXIMUM USE OF ROUGHAGE UPON THE REPRODUCTIVE EFFICIENCY OF DAIRY CATTLE

Leaders: H. A. Keener, F. E. Allen, K. S. Morrow, G. P. Percival, and C. H. Boynton with cooperation of K. C. Beeson and E. J. Thacker, U. S. Plant, Soil and Nutrition Laboratory, Ithaca, New York

The mineral content of forage produced under intensive fertilization (1951 Annual Report, page 53) was about the same the third year as the second. Timothy and bromegrass were low in iron, copper, and cobalt, while Ladino clover was low in copper and cobalt. The results of this experiment still indicate that, when relatively high yields of forage are produced on the soil type used in this experiment (Paxton loam), the minor element content of the forage may be low.

Feeding the low mineral content forage to dairy cattle resulted in slow growth, anemia, and very low milk production, but reproduction has not been affected adversely as yet.

NEW JERSEY

Title: THE IMPROVEMENT OF LADINO CLOVER BY SELECTION AND BREEDING

Leader: G. H. Ahlgren (in cooperation with A. A. Hanson, Pasture Research Laboratory)

The strains known as 6-10 x 6-13, 6-5 x 6-16, and a close-pollinated strain are in their third year of comparison with Ladino clover strains from the western states and also from Italy. During the winter of 1951 very severe winter killing occurred among all of the strains. During the harvest season 6-5 x 6-16 yielded 0.63 of a ton of dry matter compared to Oregon Certified 0.34 of a ton and the close-pollinated selection yielding 0.13 of a ton. The plots were severely contaminated with weeds and some timothy, and the yields given here are from the clover only.

The second planting, now in its fourth year, compares 6-10 x 6-13 with 18 other strains from the United States and Europe. This cross continues to look at least as good as many of the other strains and better than most. As previously recorded, it has a shorter and more dense appearance of growth than the other Ladino clovers.

Title: BREEDING PRODUCTIVE, WILT-RESISTANT ALFALFA VARIETIES ADAPTED TO HUMID EASTERN CONDITIONS

Leaders: W. R. Battle and G. H. Ahlgren (in cooperation with A. A. Hanson and J. H. Graham of the Pasture Research Laboratory)

Activities have been concerned with further improvement of the Atlantic breeding materials, increase and distribution of Atlantic seed, and development of more efficient breeding methods. Plantings presently in existence include the following:

1948 Uniform Alfalfa Nursery: 21 entries, 4 replications, plots 5 x 16 feet, randomized block design. Includes 9 named varieties, 2 experimental varieties, 1 hybrid, and 9 polycross progenies of selected clones. Harvested for hay 3 times annually. Atlantic has been the outstanding variety in this test, and Narragansett, Ranger, Buffalo, and clones C22, C63, and C230 have been good.

1950 Wilt Epidemic Nursery: originally contained 10,000 spaced plants representing 58 parental strains of Atlantic alfalfa. Each plant was inoculated with Bacterial Wilt disease in 1950 by clipping the tops and roots and immersing plants in a bacterial suspension. Four hundred eighty-nine of the best plants among those surviving the disease were selected in 1952, and seed has been harvested from them.

1951 Wilt Epidemic Nursery: originally contained 14,000 spaced plants representing progeny of 139 wilt resistant selections from 1948 Wilt Epidemic Nursery. Inoculated with wilt disease as outlined above. This nursery represents the second cycle of selection for wilt resistance.

Survival of the progenies averages about twice that of the Atlantic checks, and certain of the progenies are almost completely resistant.

1950 Plant Introduction Nursery: 6 foot rows, 2 replications, randomized, 75 strains of alfalfa from Europe, Asia, and Africa are undergoing preliminary evaluation for vigor and general agronomic characters. Several strains from Turkey have been outstanding in this test.

1952 Seedling Vigor Nursery: 4 foot rows, 4 replications, 12 by 12 lattice design. One hundred forty-four progenies of selected plants are being studied to determine the transmission of seedling vigor from parent to progeny. Previous studies at this Station indicate that the length of the primary stems of young seedlings may be indicative of mature yielding ability.

1940 Atlantic Breeders Seed Field: One-half acre in area. Parental stock of the Atlantic variety, seeded in rows, one foot apart. This field has been harvested for seed annually since 1941, and still has a fairly good stand. Seed has been sent to Western States each year for seed increase purposes. All of the Atlantic alfalfa now in existence traces back to this field.

1951 Atlantic Breeders Seed Field: 5 acres in area, plants spaced 28 inches by 28 inches apart. Harvested for seed for first time in 1952. This increased area for breeders seed production was needed in order to produce enough stock seed to meet the demand among Western seed growers. It is estimated that a market exists for at least 5 million pounds of Certified Atlantic alfalfa seed each year.

1952 Seed Source Test: Includes seed lots of Atlantic, Buffalo, and Ranger alfalfa representing Breeder, Foundation, Registered, and Certified generations from several states and various ages of stand. Four replications each of 110 entries, seeded broadcast in plots measuring 6 x 20 feet. This test is cooperative among the Division of Forage Crops and Diseases, USDA, and several of the state experiment stations, and is intended to determine whether alfalfa varieties change under present methods and conditions of seed multiplication.

Title: WINTERKILLING STUDIES WITH LADINO CLOVER

Leader: M. A. Sprague

The study on effect of rate of freezing on survival of Ladino clover (1951 Annual Report, page 55) was tested and found to be consistent in the case of alfalfa also. Freezing point determinations placed the freezing point of alfalfa crown tissue at approximately 26.5°F.

Measurements of the microclimate in the field during January and February 1952 showed a more stable temperature less inclined to rapid changes beneath a grass cover than above or in the absence of a grass cover. Differential winter killing during the winter indicated beneficial effects from grass in association with clovers.

Title: PASTURE RENOVATION STUDIES

Leader: M. A. Sprague

Principles of renovation established by previous small plot trials (1951 Annual Report, pages 54-55) were incorporated in field size tests in central and northern New Jersey. A total of 6 old bluegrass pastures from 3 to 7 acres each was renovated and reseeded in August 1952. Successful seedings were obtained in all tests involving new seedings of bromegrass, orchardgrass, alfalfa, birdsfoot trefoil, red clover, Ladino clover, and oats. Both fall and spring seeding schedules were included with different amounts of tillage applied.

There was excellent general acceptance of this chemical method of renovation by farmers and several indicated plans to undertake it independently. Of outstanding importance was the fine evenly distributed mulch left on the surface and its effectiveness in reducing the danger from erosion. Additional benefit from the mulch was its effect of aiding in the establishment of spring sown clovers.

Title: CONTROL OF CHICKWEED (Stellaria media) IN ALFALFA

Leader: R. J. Aldrich

The use of chemicals for controlling chickweed has been under investigation for the past three growing seasons. 4,6-Dinitro-o-sec-butylphenol (DNOSBP) and isopropyl-N-(3-chlorophenyl)carbamate (Chloro-IPC) appeared promising for chickweed control in the 1949-50 studies. The 1950-51 and 1951-52 tests were designed to provide information on rate per acre, date of application, and volume of water necessary for best results with these two herbicides.

Results to date indicate that heavy chickweed populations significantly reduce yields of established and seedling alfalfa. The reduction in yields was most pronounced in the first cutting and has been most significant in first year alfalfa. In at least one instance, alfalfa stands were significantly reduced by a severe chickweed infestation. Effective control with chemicals has resulted in as much as a 45 per cent increase in alfalfa yield.

Chickweed was effectively controlled with 3 pounds of Chloro-IPC used in all dates and in all volumes of water. This included application during the period from October through February in 10, 20, 40, and 100 gallons of water. Results in 1950-51 indicated that 6 pounds of Chloro-IPC per acre was near the maximum which could be tolerated by alfalfa and 12 pounds applied in January resulted in severe inhibition. On the basis of results to date, it would not appear that the lowest effective rate has been established for Chloro-IPC.

A single application of one pound of DNOSBP per acre satisfactorily controlled chickweed when applied before chickweed became matted and providing climatic conditions were not conducive to new germination and regrowth of chickweed. The volume of water in which DNOSBP is

applied would not appear to be critical although control obtained in 10 gallons of water per acre was slightly less than in 20, 40, and 100 gallons of water. After the chickweed became matted it was not effectively controlled by single applications in even the highest volume of water per acre.

Logically, it would seem advisable to eliminate chickweed as early as possible so that it will offer a minimum of competition to the establishment of the alfalfa. Although excellent results have been obtained with some applications made prior to frost in the fall, where heaving conditions prevailed serious reductions in alfalfa stands have resulted by these early treatments. Chickweed was effectively controlled with 1 pound of DNOSBP applied in October in the fall of 1951; a similar application in 1950 was followed by considerable chickweed regrowth. The fall of 1951 was not typical as far as chickweed development conditions are concerned. Dry weather during September delayed chickweed germination so that October applications were made on relatively much smaller chickweed plants than was the case in 1950. Since it is desirable to eliminate chickweed as early in the fall as is feasible and yet it does not appear that a single application of DNOSBP at this time will do the job, repeat applications have considerable merit. On the basis of results with repeat treatments in 1951-52 it appears that it may be possible to use slightly less material at each application than is necessary if a single application only is relied on.

Title: TIME OF CUTTING STUDIES WITH GRASS SILAGE CROPS

Leaders: Claude Eby and M. A. Sprague

This study (1951 Annual Report, page 59) was continued through a second cutting season. Marked differences in stand indicated early cutting favored Ladino clover in associations with bromegrass and reed canarygrass but had little effect in association with orchardgrass. Late spring cutting (at bloom stage of the grass) favored the two grasses compared with the clover. The early spring cutting had much greater effect of suppressing the grasses in mixtures containing Ladino clover than where trefoil was the legume partner.

Title: THE RESPONSE OF ALFALFA VARIETIES TO DIFFERENT FERTILIZER LEVELS

Leaders: H. D. Gross, E. R. Purvis, and G. H. Ahlgren

This project is a continuation of that given in the 1951 Annual Report, page 58. The data secured this past season complete the investigations. The test included four adapted varieties: Atlantic, Buffalo, Kansas Common, and Ranger, under 12 fertilizer treatments, and the study extended over a period of 6 years.

There was a significant increase in yield due to fertilization and a significant difference among the varieties as regards yield and persistence. No variety x treatments interaction was obtained, however.

High potash applications proved to be essential for long-lived high yielding alfalfa stands. At no time were nitrogen, phosphorus, and boron limiting elements in this test.

As proposed by certain other investigators, alfalfa varieties with broad genetic bases would not be expected to respond differently to fertilizer treatments. The varieties included in this test presumably are of that nature. It is concluded that, where adapted varieties and major fertilizer elements are involved, the generally recommended practice of fertilizing all alfalfa varieties alike is a sound one.

Title: EFFECT OF TIME OF FERTILIZING ALFALFA

Leaders: John L. Gerwig and G. H. Ahlgren

A study of the effect of time of fertilizing alfalfa was started in August 1952. The Atlantic variety of alfalfa, seeded at about 20 pounds per acre, was broadcast uniformly over the experimental area. All plots received an initial application of 500 pounds per acre of 5-10-10 fertilizer. An application of 1000 pounds of 0-10-20 fertilizer per annum will be applied at various times throughout the growing season to 6 x 12 foot plots, arranged in a randomized block design with five replications. Studies will be made of the response to the various times of applications in terms of yield, persistence, botanical composition, and nutrient return. Present plans include the application of insecticide dust for forage insect control.

Title: EFFECT OF PLANT FOOD COMBINATION ON ALFALFA

Leaders: John L. Gerwig and G. H. Ahlgren

A study of the effect of varying fertilizer rates and ratios on alfalfa was started in August 1952. The Atlantic variety of alfalfa, seeded at about 20 pounds per acre, was broadcast uniformly over the experimental area. All plots received an initial application of 500 pounds per acre of 5-10-10 fertilizer. Varying fertilizer treatments will be applied in the spring to 6 x 12 foot plots, arranged in a randomized block design with five replications. Applications of fertilizer elements will range up to 200 pounds per acre of nitrogen and 400 pounds per acre of P_2O_5 and K_2O, in varying combinations. Studies will be made of the response to the various treatments in terms of yield, persistence, botanical composition, and nutrient return. Present plans include the application of insecticide dust for forage insect control.

Title: EFFECT OF TIME OF FERTILIZING BIRDSFOOT TREFOIL

Leaders: John L. Gerwig and G. H. Ahlgren

A study of the effect of time of fertilizing birdsfoot trefoil was started in August 1952. Imported Italian broadleaf birdsfoot trefoil, seeded at about 6 pounds per acre, was broadcast uniformly over the experimental area. All plots received an initial application of 500 pounds per acre of 5-10-10 fertilizer. An application of 1000 pounds per acre of 0-10-20 fertilizer per annum will be applied at various times throughout the growing season to 6 x 12 foot plots, arranged in a randomized block design with five replications. Studies will be made of the response to the various times of application in terms of yield, persistence, botanical composition, and nutrient return. Present plans include the application of insecticide dust for forage insect control.

Title: EFFECT OF PLANT FOOD COMBINATION ON BIRDSFOOT TREFOIL

Leaders: John L. Gerwig and G. H. Ahlgren

A study of the effect of varying fertilizer rates and ratios on birdsfoot trefoil was started in August 1952. Imported Italian broadleaf birdsfoot trefoil, seeded at about 6 pounds per acre, was broadcast uniformly over the experimental area. All plots received an initial application of 500 pounds per acre of 5-10-10 fertilizer. Varying fertilizer treatments will be applied in the spring to 6 x 12 foot plots, arranged in a randomized block design with five replications. Applications of fertilizer elements will range up to 200 pounds per acre of nitrogen and 400 pounds per acre of P_2O_5 and K_2O, in varying combinations. Studies will be made of the response to the various treatments in terms of yield, persistence, botanical composition, and nutrient return. Present plans include the application of insecticide dust for forage insect control.

Title: THE EFFECT OF TIME OF FERTILIZATION UPON PASTURE YIELD

Leader: E. R. Purvis

For the third consecutive year, no significant differences in total annual yield due to time of application were obtained when 750 pounds to the acre applications of 5-10-10 fertilizer were made in the fall, early spring, and after first harvest (1951 Annual Report, page 57). Applying fertilizer after first harvest resulted in significantly higher yields at second or third harvest, those increases compensating for the reduced yields obtained from this treatment at first harvest.

Tests were conducted on improved pasture at two locations. Plots were harvested four times during the season.

Title: UTILIZATION OF PASTURE IN THE PRODUCTION OF BEEF

Leaders: George Vander Noot and M. A. Sprague

For 3 years eight steers (average 525 pounds) were pastured on 21 acres and made an average gain of 206 pounds of beef per acre per season from grazing alone (1951 Annual Report, pages 59-60). In addition an average of 3.3 tons of silage was harvested.

During 1952 a new 3-year period was begun in which heavier steers are used. In April 1952 14 Hereford steers averaging 875 pounds each were put onto the 21 acres. One 4.6 acre pasture had been reseeded to rye, orchardgrass, and Ladino clover the previous fall and this was grazed first. During 170 pasture days the 14 animals averaged 1.74 pounds gain per day, an average of 197 pounds per acre for the season. In addition 2.4 tons per acre of silage was removed in May, enough to feed 14 animals 50 pounds per day for 150 days during the winter. This yield per unit of land area with heavy animals was approximately the same as with the lighter animals of the 3 years previous, though the gain per animal was greater.

CORNELL UNIVERSITY (NEW YORK)

Title: BREEDING AND CYTOGENETIC INVESTIGATIONS WITH THE FORAGE PLANTS OF NEW YORK

Leaders: R. P. Murphy, C. C. Lowe, S. S. Atwood, and D. L. Smith

This report covers the fiscal year 1951-52 (1951 Annual Report, page 61). The breeding and cytogenetic studies are described here separately for each species.

A. Alfalfa

1946, 1947, 1948, 1949, 1950 Uniform Observational Nurseries: Notes on persistence, vigor, disease reaction, and insect reaction were taken. From these data the materials which are superior are selected for use in the more advanced stages in the breeding program.

1948, 1949, 1950 Clonal Nurseries: These were studied again in 1951. The 1948 nursery will be discarded in 1952. The selected clones have been transferred to a maintenance nursery.

1951 Maintenance Nursery: All clones of value to the research program are maintained in rows of ten cuttings for each clone.

1949 Single Cross and Inbred Nurseries: These progenies were studied in 1951 and especially noted for persistence and vigor. The selections made from the 1950 data continued to be superior in 1951. Twelve single crosses were selected for increase. Their advanced generations will be studied as possible new varieties. In addition several of the double crosses that can be produced will be made and tested as possible new varieties.

1950 Single Cross and Inbred Nursery: These progenies were studied intensively in 1951. Some of the plants from crosses between creeping-rooted parents from Saskatchewan and parents adapted in New York possessed the creeping-rooted characteristics. These plants will be studied in detail in 1952 and the entire nursery is serving as a source of new clones.

1951 Seedling Source Nursery: A number of seedlings from diverse origins was established to serve as a source of new clones.

Disease Resistance Studies: The plants with the most resistance to bacterial wilt planted in the field in 1951 will be selected for other desirable characteristics. The study of the inheritance of resistance to common leafspot by Mr. R. D. Ensign progressed well in 1951. A number of plants isolated with a relatively high degree of resistance will be selected for other desirable characteristics.

Insect Reaction Tests: A study of the inheritance of reaction to potato leaf hopper was started.

Carotene Study: A study of the variability and inheritance of green color and carotene was initiated.

B. Red Clover: Seed will be harvested from the surviving plants from the 1950 planting which will complete the second cycle of selection for persistence.

C. Ladino Clover

1951 Clonal Nursery: Several clones from the U. S. Regional Pasture Laboratory were established in a replicated nursery.

1951 Seedling Nursery: The polycross seedling progenies of the parental clones of experimental synthetic, F.C. 23,608, were established in replicated 10-plant rows. This nursery will be a progeny test and may also serve as a source of new clones.

D. Zig-Zag Clover: The few clones are being maintained.

E. Alfalfa, Clover and Grass Introduction Nursery: The materials described last year were studied for their desirable agronomic characteristics. Several collections of alfalfa and clover winterkilled and most collections of canarygrass also winterkilled. A few collections of alfalfa and bromegrass seemed to merit further study. One collection of alfalfa with pubescent stems and leaves has been included in the study on leaf hopper resistance.

F. Clover and Birdsfoot Trefoil Interspecific Hybridization: Some degree of success was obtained. By the use of embryo culture crosses between T. ambiguum and T. hybridum were obtained but no F_1 plants lived long enough to flower. Crosses between T. nigrescens and T. repens were successful.

G. Bromegrass

1948 Inbred and Single Cross Nurseries: These nurseries were discarded after the 268 selected plants were transferred to a maintenance nursery. The best of these will be established in a polycross seed production nursery probably in 1953.

H. Orchardgrass

1949 Polycross Seed Production Nursery: This nursery was discarded in 1951 after 68 of the clones selected for progeny testing were transferred to the maintenance nursery.

I. Tall Oatgrass

1949 Polycross Seed Production Nursery: This nursery was discarded in 1951 after 64 of the clones selected for progeny testing were transferred to the maintenance nursery.

J. 1947 Technic Study, Aftermath Study, and Other Studies: The study on inheritance of self-incompatibility in diploid and tetraploid white clover has been continued.

Title: THE EVALUATION OF FORAGE CROPS VARIETIES AND STRAINS FOR THEIR USE AND ADAPTATION IN THE NORTHEAST. SUB-PROJECT 1: EVALUATION OF FORAGE CROPS VARIETIES AND BREEDING MATERIALS FOR NEW YORK

Leaders: R. P. Murphy, C. C. Lowe, S. S. Atwood, W. F. Keim, and E. M. Sprague

This report covers the fiscal year 1951-52 (1951 Annual Report, page 65). The progeny testing of selected plants and other research conducted under this project will be reported here separately for each species.

A. Alfalfa

1948 Ranger Increase Study: Further data were obtained from this study in 1951. The results continue to indicate that the six seed increases of Ranger which were eligible for certification were similar in performance. They were also similar to the Breeder's seed lot. However, two other increases which were ineligible for certification showed some measurable differences from the certified lots. They were not different in yield but "hardened-off" less in the fall and thus may be less winterhardy.

1948 New York Polycross Progeny Test: This nursery is being maintained as a source nursery for new clones.

1948, 1949, 1950, 1951 Uniform Advanced Nurseries: These replicated plot trials are conducted in cooperation with the Division of Forage Crops and Diseases of the USDA. A number of good clones were isolated on the basis of these tests of their polycross progeny. Several new experimental varieties were selected for further testing because of their good performance. The information on standard varieties, used as checks, was used along with other tests as a basis for variety recommendations.

1950 New York Polycross Progeny Test: This replicated plot test was studied and from the first year of testing it seems that some of the clones produced very good progenies.

1951 Alfalfa Generation Study: This experiment includes the study of four advanced seed generations of 19 synthetics and single crosses along with six standard check varieties. Good stands were obtained.

B. Bromegrass

1948 Polycross Progeny Test: Yields for two cuttings were obtained. The clones which produced the best progenies in this test will be used in further breeding as parents of new clones and of experimental synthetic varieties. This test will be discarded.

1949 Polycross Progeny Test: For the three different groups of clones tested, yields for two cuttings were obtained. As explained above the best clones will be used in further breeding. This test will be discontinued.

1950 Polycross Progeny Test: Yields for two cuttings and detailed notes on diseases, color, leafiness, etc. were obtained. This test will be continued in 1952.

1951 Polycross Progeny Test: This planting was established with good stands.

Isolation Plots of Experimental Synthetics for Seed Production: The seed of the first synthetic generation was harvested from six of these and the seed of the second synthetic generation was harvested from five. Three new synthetics were established in isolated plots in 1951 for the production of seed. These experimental synthetic varieties are tested in regular variety trials against standard check varieties.

C. Orchardgrass

1950 Polycross Progeny Tests: Yields for three cuttings and detailed notes on diseases, color, etc. were obtained. This test, which includes four maturity groups, will be continued in 1952.

1951 Polycross Progeny Tests: This test includes four maturity groups. Good stands were obtained.

Isolation Plots of Experimental Synthetics for Seed Production: Seed of the first synthetic generation of two synthetics was harvested. Isolated plots for the production of the seed of the second synthetic generation for these two synthetics were established in 1951. Also isolated plots for four new synthetics were established.

D. Timothy

1950 Polycross Progeny Test: Yields for two cuttings and detailed notes on diseases, color, leafiness, maturity, etc. were obtained. A number of desirable progenies of mid to late maturity were found.

Isolation Plots of Experimental Synthetics for Seed Production: First-generation seed was harvested from three synthetics.

E. Reed Canarygrass

1950 Polycross Progeny Test: Yields for two cuttings and notes on color, etc. were obtained.

Isolation Plots of Experimental Synthetics for Seed Production: First-generation seed was harvested from three synthetics.

F. Tall Oatgrass

1951 Polycross Progeny Test: This planting was established with good stands.

Isolation Plots of Experimental Synthetics for Seed Production: Isolated plots for three synthetics were established.

G. Maintentance Nursery: This nursery was maintained and necessarily expanded by the addition of new selected clones from all the species. All clones which are currently being progeny tested or used as parents of an experimental synthetic variety and all others which might be of some value to the breeding program now or in the future are maintained.

Title: STRAIN TESTING AND BREEDING OF FORAGE PLANTS FOR NEW YORK STATE AND VICINITY, WITH SPECIAL EMPHASIS ON PROBLEMS OF PRODUCTION DURING PERIODS OF MIDSUMMER DROUGHT

Leaders: R. P. Murphy, C. G. Lowe, S. S. Atwood, A. A. Johnson, H. A. MacDonald, R. D. Ensign, and N. L. Taylor

This report covers the fiscal year 1951-52 (1951 Annual Report, page 63). A summary of the results of the strain and variety testing to date for each species included is given in the following statement.

During the past six years, extensive tests were made of the wide range of forage crops varieties and strains. These varieties and strains included: (1) commercial varieties now in use, (2) new varieties not yet released, and (3) local ecotypes developed through natural selection;

and these were tested against commercial lots commonly available. These tests have been located at Ithaca, Churchville (Monroe County), and Tully (Onondaga County) for the most part, and in farmers' fields in eight counties.

Considerable use was made of the data obtained to date. The results have been the basis for the variety recommendations for forage crops. Although the results were not published, they were presented to seedsmen and county agents for their use.

Alfalfa: Ranger was the most winter hardy of the varieties which are resistant to bacterial wilt disease. Where the wilt disease caused depletion of stands, Ranger persisted much longer than susceptible varieties such as Grimm, Northern Variegated, and Kansas Common, if the stands were properly fertilized and managed. Narragansett was found to be very winter hardy and well adapted throughout the State. It is not resistant to bacterial wilt but has been a high yielder for three years even where the disease is present. Under many conditions it produced stands and yields superior to all other varieties. Atlantic performed well in central and southern New York and was superior to all other varieties except Narragansett. It is lacking in winter hardiness for northern New York and is intermediate to susceptible to bacterial wilt. Seed of Ranger is available and seed of Narragansett and Atlantic will be available in quantity in the next two or three years and it is expected that Ranger and Narragansett will be the major varieties of alfalfa for use in the State. A variety with more resistance to bacterial wilt and greater winter hardiness than Ranger is needed. Several experimental synthetic varieties seem promising in this regard and are being tested as extensively as seed supplies will permit.

Red Clover: Pennscott, Kenland, and commercial seed from New York and neighboring states gave higher yields than commercial seed from the Cornbelt and the West. It is expected that Pennscott will be widely used in the State as soon as seed is available.

Ladino Clover: Certified seed of this crop, produced primarily in the far West, was superior in yield and density of stand to imported lots and to uncertified lots produced in the West and other areas. The U.S.D.A. selection has performed well in tests to date.

Bromegrass: Lincoln, Achenbach, Fischer, and Elsberry were superior to Canadian commercial lots in seedling establishment, yield, early spring growth, and resistance to brown leafspot. Some of the experimental synthetic varieties developed in New York appear promising.

Timothy: No varieties were found superior in yield to much of the commercial seed, but some later in maturity seem to have an important place in New York. Varieties such as Climax were 7 to 10 days later in maturity than most commercial timothy, and grew well in association with Empire birdsfoot trefoil, a late maturing hay legume.

Orchardgrass: No varieties were found superior in yield to much of the commercial seed. The value of varieties which are later in maturity is being investigated further.

Meadow and Tall Fescue: These species seem to have a very limited use in New York. Alta and Kentucky 31 (varieties of tall fescue) have been superior to other sorts in these tests. No further work with fescue is planned.

Reed Canarygrass: Ioreed seems to be as good as any of the varieties and farmer lots tested. Superior, from Oregon, has winterkilled almost completely in all tests.

Tall Oatgrass: Tualatin, from Oregon, has been about equal to commercial lots in yield and is about three days later in maturity. This variety shatters less than others and, thus, is more suitable for seed production. It seems to have a very limited use in New York.

Sudan Grass: The Wisconsin selection, named Piper, which has just been released has been equal to Wheeler and Calapproved No. 23 in yield and is superior to these in disease resistance and freedom from prussic acid.

Title: SOME FACTORS AFFECTING SEEDLING ESTABLISHMENT OF FORAGE PLANTS

Leader: H. A. MacDonald

The studies within this project during the past year were a continuation of those reported for 1951 (1951 Annual Report, page 67). Special emphasis was given to depth and method of seeding, however, and some of the findings are being presented.

The studies included the influence of varying seeding depth, methods of coverage, compaction, and mulching upon the emergence of various grasses and legumes. This work is not completed as yet.

In Figure 4 is presented the pertinent information regarding the influence of seeding depth upon emergence of nine grasses and four legumes.

From the information now at hand the following summary may be presented:

1. A tilled friable seedbed gave best seedling establishment.
2. In general, the larger the seed the deeper it could be seeded with success.
3. Small seeds gave poor results when placed at a depth greater than 2 cm.
4. All species studied gave maximum emergence when planted at a depth of about 1 cm.
5. Only a few of the larger seeds emerged when planted at a depth greater than 5 cm. (2 inches).
6. Of the grasses studied redtop had the smallest depth range for successful emergence and bromegrass the greatest. Of the legumes, white clover (common) had the least and red clover the greatest.

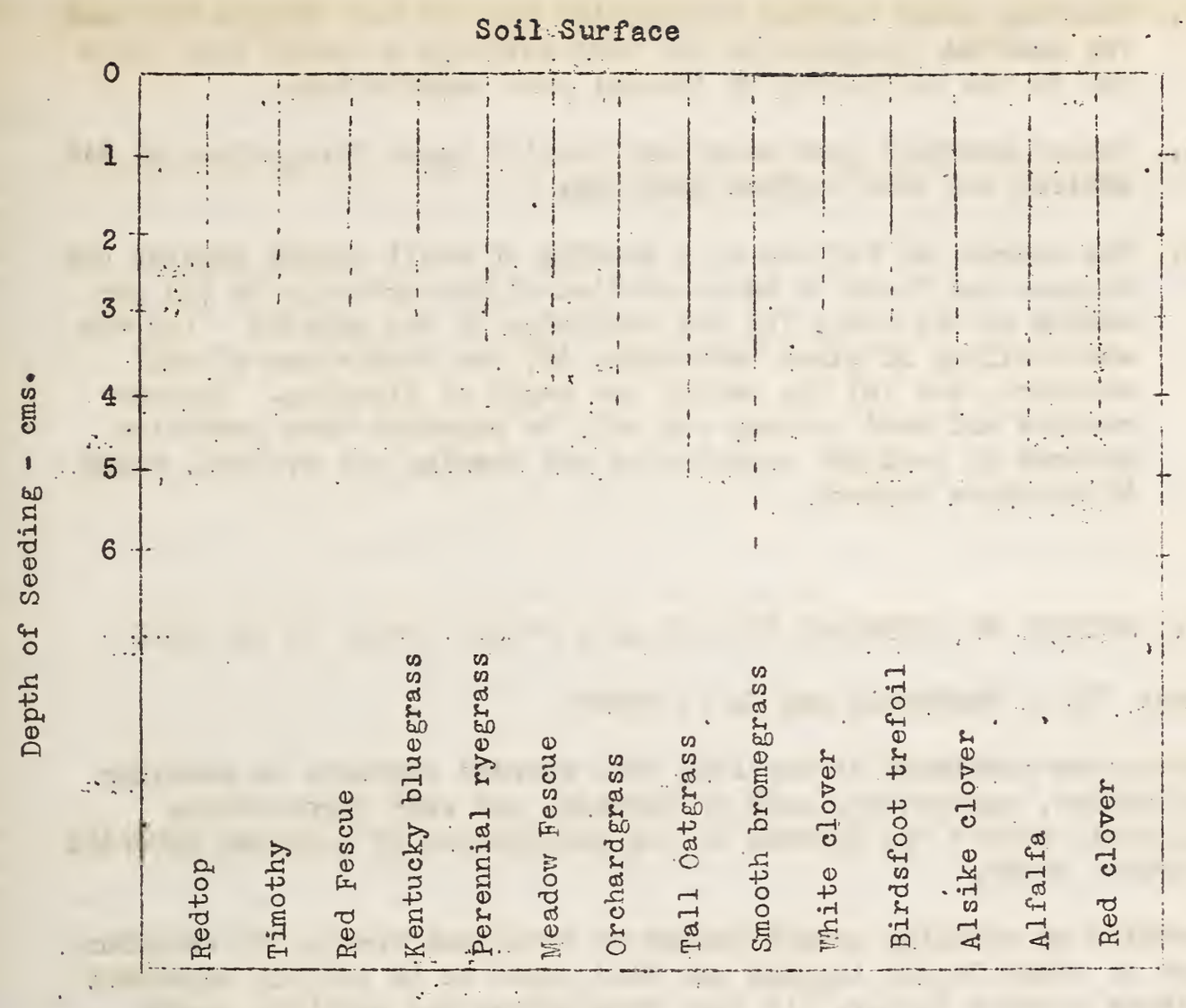

Figure 4. Influence of the depth of seeding on the emergence of some forage grasses and legumes.

| Range of good emergence and establishment

: Range of sparse emergence

7. Within a given species the larger seeds gave the stronger emergence at deeper plantings and the smaller seeds the weaker.

8. Surface seeding gave poor results except where natural cover resulted from a rough or loose seedbed surface.

9. The number of days required for emergence increased with increased depth of seeding. Surface seeding gave variable results; being slower to germinate and giving poorer establishment than the shallow covered seedings due to varying conditions of soil moisture and soil penetration.

10. Rolling or seedbed compaction following seeding improved surface seedings by providing some coverage. It improved shallow seedings by improving soil-seed contact; it resulted in reduced emergence of deep seedings.

11. Mulching aided initial germination but did not obviate the need for seedbed preparation and seed coverage on heavy clay soils due to the difficulty of initial root penetration.

12. Summer seedings gave excellent results under irrigation, as did shallow and even surface seedings.

13. The success or failure of a seeding of small seeded grasses and legumes was found to be controlled almost entirely by (a) the nature of the soil, (b) the condition of the seedbed (c) the availability of plant nutrients, (d) the conditions of soil moisture, and (e) the method and depth of planting. Maximum success and seed economy can only be expected when precision methods of seedbed preparation and seeding are devised, aided by moisture control.

Title: STUDIES OF BIRDSFOOT TREFOIL AS A FORAGE LEGUME IN NEW YORK

Leaders: H. A. MacDonald and C. S. Brown

Investigation continued during 1952 with special emphasis on seedling establishment, management, seed production, and crop improvement. Considerable effort was devoted to the propagation of selected material for further study.

The problem of seedling establishment of birdsfoot trefoil in relation to that of other forage legumes has been found to be largely dependent upon three primary factors (1) slow germination and seedling growth increasing the hazards of drought, deep coverage, and seedling competition, (2) high hard seed percentage reducing the effective seeding rate and (3) inferior or inadequate inoculation. In addition to these, inadequate lime and soil fertility frequently results in seeding failure.

The management of different birdsfoot trefoil types and varieties has been found to be quite different, more so than with the varieties of most forage species. The Empire variety performs well under a management system approaching that required by Ladino white clover while the early commercial forms, Viking, Granger, Cascade, etc. require a management system approaching that of alfalfa.

The problem of seed production requires much further study. The vagaries of climate play a primary part in limiting seed production success in this region.

The early Viking variety was established for increase in four areas within the State. The first sizable increase of this variety will be produced in the fall of 1953. It should fill in important agricultural needs on many farms.

Title: THE EFFECT OF STAGE OF GROWTH UPON THE YIELD, NUTRITIONAL VALUE, AND LONGEVITY OF THE PRINCIPAL FORAGE GRASSES AND LEGUMES

Leader: H. A. MacDonald

The work carried out under this project during the past year was confined, for the most part, to studies involving the relationship of plant type and form to the most desirable management system for persistent, high quality production. In much of this work it has been found that primary differences, while they are the governing influences, set up secondary effects which actually control the factors under study.

In studies with alfalfa it was found that the influences of summer and fall climate together with the cutting treatment, or management practice, controlled the build-up of root resources to such an extent as to eliminate varietal and other treatment differences. The direct effect of drought conditions, semi-dormancy, and growth rate upon root reserves and subsequent performance requires further study.

Ladino white clover was studied under a variety of cultural conditions with different management treatments superimposed. The maintenance of this legume in grass mixtures was found to be determined by the ability of the stolons to maintain close soil contact and to become firmly rooted. In almost all cases where the new stolon growth did not become well rooted the plant either was killed or died. Frequent but not excessive clipping or grazing where such rooting was possible, and where light penetrated well to almost the soil surface, resulted in strong persistent plants.

The dependence upon root, crown, and basal stem reserves for the proper maintenance of most grasses was fully demonstrated. The reduction in number of grass plants and yield production was marked under a system of close clipping for erect, bunch grasses, while in the case of the vegetatively propagated grasses delayed clipping had this effect. This latter result was found to be due to (a) a reduction in the amount of light reaching the new clones as they developed, and (b) a reduction in rhizome growth with the development of reproductive plant parts.

Much more detailed studies regarding the life history of crop plants under varying conditions of culture and management are urgently needed.

Title: RATE AND DATE OF APPLYING NITROGEN FERTILIZER TO GRASS PASTURES

Leaders: W. K. Kennedy, R. Bradfield, and E. F. Sullivan

In 1951 and 1952 nitrogen alone and in a complete fertilizer was applied to irrigated and nonirrigated Ladino clover-grass mixtures harvested four or five times during the growing season to simulate a grazing treatment. The nitrogen was applied as three or four applications during the season on about May 1, June 1, July 15, and September 1.

When 200 pounds of nitrogen was applied to the mixtures in their first harvest year summer production was increased as much as 3600 pounds of dry matter over the no-nitrogen plots. This rate of fertilization eliminated the clover from the orchardgrass mixture but not from the bromegrass mixture. In the second harvest year the increase in production, due to continued nitrogen fertilization, was small although 100 pounds of P_2O_5 per acre were applied annually. This raises a question whether a proper mineral balance was maintained or if a combination of nitrogen fertilization and frequent clipping seriously depleted the root reserves of the grasses. Further work on the use of nitrogen to maintain high grass yields is needed.

Title: THE EFFECT OF HERBICIDES ON THE RATE OF DRYING OF FORAGE CROPS

Leaders: W. K. Kennedy, R. Bradfield, and Walter Hesse

The results obtained on this project were similar to those reported last year (1951 Annual Report, page 70). Forage treated with herbicides did not dry much faster than untreated material unless the chemicals were applied 24 or 48 hours before cutting. The leaves of herbage treated with effective herbicides dried much faster than the leaves of untreated forage but the stems of treated forage frequently dried more slowly than the stems of untreated forage. Contact herbicides were much more effective than 2,4-D or similar translocated materials but leaf browning and sometimes leaf loss were excessive. At the present time use of herbicides does not appear to be an effective way of increasing the rate of drying of forage crops.

Title: THE USE OF FUNGICIDES TO PRESERVE MOIST HAY AND GRAIN

Leaders: W. K. Kennedy, R. Bradfield, Roy U. Schenk, J. Thomas Reid, George Trimberger, and K. L. Turk

The work previously reported (1951 Annual Report, pages 70-71) has been continued. The toxicity and feeding value of hay treated with five and ten pounds per ton of 2, 4, 6-trichlorophenol are being studied with dairy cows and sheep. It has been hypothesized that, unless the chemical alters the rumen flora, treated hay will be higher in digestibility than untreated hay because it has not been damaged by mold or heating as has the untreated hay. This phase of the study is in progress.

Further evaluation of chemicals indicates that the bromo- and chlorobenzenes are not suitable as hay and grain preservatives while the bromo- and chloro- phenols are the most promising compounds tested.

Wheat, oats, and corn with moisture contents too high for safe storage have been successfully treated and preserved with 2, 4, 6-trichlorophenol. Treatment not only prevents mold growth but also materially reduces heating since mold respiration is inhibited.

Title: FURTHER STUDIES ON THE FEEDING OF INSECTICIDE TREATED HAY TO DAIRY CATTLE

Leaders: George G. Gyrisco, L. B. Norton, A. A. Muka, and Lemac Hopkins

Work was continued during 1952 on the feeding of insecticide-treated hay to dairy cattle. DDT, methoxychlor, lindane, aldrin, and parathion were applied to hay just prior to feeding at the rates of 2, 4, and 10 ppm. Each insecticide was fed to two dairy cows for three months, the first month at the low rate, and the second and third months at the middle and high rates, respectively. Milk was sampled for residues at weekly or shorter intervals during the entire 91 day experimental period.

Briefly the results may be summarized as follows: No methoxychlor or parathion was detected in any of the milk samples. None of the values for lindane residues in the milk exceeded a level above the normally expected variations in the analytical techniques employed, as the average was not significantly greater than zero. Since the aldrin samples were erratic, duplicate samples will be re-analyzed using newer analytical procedures. When DDT was fed up to 4 ppm during the 60-day period, the residue exceeded 0.1 ppm only on one occasion. However, when 10 ppm of DDT were fed, the residue reached 0.2 ppm on several sampling dates.

None of the milk samples had any off-flavor or odor that could be attributed to any of the insecticide treatments. These milk samples were tasted by qualified milk tasters.

The health, weight, butterfat, and milk production of all the cows showed no abnormal fluctuations during the course of the experiment that could be attributed to the insecticides.

Analysis of the manure from each animal showed no residue to be present except in the case of the cows fed DDT where the residue was found to be in proportion to the different levels fed.

After slaughtering, the lindane cow showed 0.25 ppm and 0.08 ppm of residue, respectively, in the omental fat and kidney. The aldrin cow showed no residue to be present in these tissues with the method of analysis available. Some DDT residue was found in the omental fat and kidneys of the DDT cow (6.6 and 0.6 ppm, respectively).

In a separate experiment comparing field treated DDT hay with an equal level of DDT residue by treating hay in the barn (with the insecticide dissolved in acetone) just prior to feeding, it was found that the barn treated hay gave residues in the milk equal to or greater than those from the field treated hay indicating that artificial treatment of the hay did not reduce the possibility of the residues being found in the milk.

Title: ALFALFA SNOUT BEETLE INVESTIGATIONS

Leaders: George G. Gyrisco, A. A. Muka, and C. E. Palm

Further work (1951 Annual Report, pages 71-72) was conducted during 1952 with sprays, mists, and new improved baits using several of the new chlorinated hydrocarbons and organophosphates.

Using the Buffalo turbine mist blower with a fish tail outlet and a circular outlet and applying aldrin at the rate of 1 pound per acre it was found that the fish tail outlet was superior to the circular outlet. In general however mist blowers did not give adequate control beyond 25 feet and were not as effective as low gallonage, low pressure weed sprayers. In both cases, 20 or more gallons of spray per acre were superior to smaller gallonages.

In the low gallonage spray plots, lindane, aldrin, toxaphene, methoxychlor, parathion, isodrin, and metacide were used as emulsions and applied at the rates of 1 and 2 pounds per acre. At the end of 2 weeks all materials gave 93 per cent or more kill of the adults present. However, in every case the lower dosage gave poorer kills for the first 48 hours. This was particularly true with methoxychlor, toxaphene, lindane, and aldrin.

In the bait tests (when substituted for sodium fluosilicate in the standard alfalfa snout beetle formula) it was found that 2 ounces per acre of aldrin and heptachlor gave 100 per cent and 97 per cent kills, respectively. While 4 ounces of chlordane gave 89 per cent control when counts were taken 1 week after application, endrin and isodrin at 2 ounces per acre in the bait gave 100 and 92 per cent reductions, respectively, in 1 week. All of these insecticides were found to be superior to sodium fluosilicate in persistence of toxicity and were able to withstand long severe periods of weathering under laboratory conditions.

Title: EUROPEAN CHAFER STUDIES

Leaders: R. H. Burrage and George G. Gyrisco

The European chafer investigations during 1952 were divided into three main categories; biology of adults, biology of the larvae, and chemical control of the larvae in pasture sod.

Studies of the adults consisted of investigations of the flight habits, sex ratios, oviposition sites, and oviposition potential. It was found that during 1952, the flight season lasted approximately 30 days with the peak of flight occurring at the end of June. The male:female ratios varied directly with the intensity of flight and averaged between 1:1 and 2:1 for the season. The data indicated that male beetles make more flights during the season than do females. Temperatures above 60 degrees, relative humidity below 100 per cent, and wind velocity did not appear to influence flight. Rainfall or temperatures below 60 degrees F usually reduced the intensity of the flight.

It was found that the beetles preferred sod to fallow ground for sites of oviposition but did not seem to show any obvious preference for short or long grass. Dissection of females indicated that 0 to 52 eggs may be present but the average value was about 20 eggs per female. It was also found that the beetles laid about 75 per cent of their eggs within a 2 week period; hence any control directed against the beetles should be used prior to and during this short period to be most effective.

The effects of soil pH, soil moisture, organic content, texture, and topography upon the distribution of the larvae within pasture areas were studied. The data indicate that all of these factors influence distribution of the grubs in the soil but their interrelationships are too complex to make any specific correlations with data now on hand.

Experiments with aldrin, dieldrin, heptachlor, chlordane, parathion, benzene hexachloride, and DDT as soil treatments for the control of the grubs were continued during 1952. Dieldrin and aldrin, each at the rate of 1 pound per acre, and DDT at 10 pounds per acre gave excellent control of 4 generations of grubs. Heptachlor at 2 pounds per acre gave good control of 3 generations of larvae. Isodrin and endrin at 1.0 and 2.5 pounds per acre, respectively, gave good control of the 1 generation of grubs on which they were tested.

Title: CLOVER ROOT BORER STUDIES

Leaders: George G. Gyrisco, A. A. Muka, and Lemac Hopkins

During 1952, ten organic insecticides were tested for clover root borer control and were compared with lindane as a standard. Most of the materials were used at the rate of 1 pound per acre of actual toxicant although methoxychlor and toxaphene were tried at the rate of 4 pounds per acre of actual toxicant since they had not proven satisfactory at a lower dosage. All of the insecticides were used as dusts in five separate experiments. In addition to these tests, lindane was compared at 4 different levels starting at 1.0 pound per acre and used up to 1.75 pounds per acre. Aldrin was used at 4 dosages ranging from 1.25 to 2.0 pounds per acre. Aldrin and lindane were also compared at 1 pound per acre in large size plots as sprays applied with a low gallonage weed sprayer.

In general, it was difficult to draw many conclusions as many of the experimental plots were only lightly infested. As during 1951 (1951 Annual Report, pages 71-72), aldrin, dieldrin, heptachlor, and lindane proved outstanding for clover root borer control, giving over 90 per cent control when applied at the rate of 1 pound per acre as a dust. Toxaphene and methoxychlor were unsatisfactory even at the rate of 4 pounds per acre. Isodrin and endrin showed some promise at 1 pound per acre, but further work under heavier infestations is needed before these materials can be properly evaluated.

Sprays have proven poorer than dusts for clover root borer control, but near perfect control was obtained with lindane and over 90 per cent

control with aldrin when these were applied at the rate 1.0 pound per acre in 20 gallons of spray. Less gallonage gives poorer control and should not be used.

Several of the organics, notably lindane and aldrin at the higher dosages, gave good control of the borer after the root had been infested but such control did not prevent destruction of the roots by disease organisms and hence loss of stand.

Title: SPITTLEBUG STUDIES

Leaders: George G. Gyrisco, A. A. Muka, and Lemac Hopkins

Spittlebug control studies were conducted in 28 counties during 1952. Lindane at 0.2 pound, methoxychlor at 1.0 pound, and toxaphene at 1.5 pounds per acre were the three most effective insecticides at those minimum dosages.

While nymphal populations in New York do not reach those found in New Jersey, Pennsylvania, or Ohio, they do reach destructive proportions of 100 per square foot or more, particularly on birdsfoot trefoil and pure stands of medium red clover.

Yield increases on 60 different demonstrations varied from none to 59 per cent (green weight basis) but averaged much less depending on the spittlebug nymph population and the populations of other destructive insects in the insect complex on forage crops. Some of the best yield increases read as follows: 59, 41, 41, 41, 34, 34, and 33 per cent. However it is highly doubtful that yields in New York can be doubled or trebled by spittlebug nymph control as they have been in other states since infestations in New York are not so great as they are in those states.

PENNSYLVANIA

Title: THE GENETICS AND IMPROVEMENT OF RED CLOVER

Leaders: H. R. Fortmann and H. R. Albrecht

In the variety trials conducted at different locations in the State Pennscott was the outstanding variety, outyielding the other varieties by a third to half a ton at each of the locations. Open pollinated seed from red clover plants which had been selected for their apparent ability to withstand "Fusarium" and "Sclerotinia" attack were harvested during the 1952 season. This seed will be planted for further evaluation of parent lines.

Title: THE GENETICS AND IMPROVEMENT OF BIRDSFOOT TREFOIL

Leader: H. R. Fortmann

Data from the variety yield trials continue to indicate that Viking is one of the top-yielding varieties when managed as hay and aftermath and also that seed from European sources is generally satisfactory for Pennsylvania conditions. Seed harvested in 1951 from two polycross nurseries, one consisting of 35 clones selected out of the Empire variety and the other consisting of 79 clones selected from other world sources of birdsfoot trefoil, was planted at two locations in 1952. Plantings will be evaluated in 1953 and subsequent years. Additional polycross seed was harvested in 1952 and seed of a number of these is available for testing.

Title: SPECIES, VARIETIES, AND STRAINS OF ALFALFA

Leaders: H. R. Albrecht and H. R. Fortmann

As data from the various test locations and from plantings made in 1949 through 1951 are accumulated it becomes increasingly apparent that different recommendations as to varieties must be made in the State of Pennsylvania for the various areas of the state and depending upon the duration of stand that is desired.

A. 1949 Advanced Uniform Nurseries

Southeastern Pennsylvania: In this planting, yields of the three varieties, Narragansett, Williamsburg, and Atlantic, were uniformly good in 1952. In contrast, the wilt-resistant varieties, Ranger and Buffalo, were both disappointingly poor. In addition, polycross progenies of Clone 240 and Clone 1740 were tops in yield.

Southwestern Pennsylvania: In this area the varieties Narragansett, Kansas Common, Williamsburg, and Atlantic had suffered severe stand losses and consequently were low in yields. In the same series of plots Ranger, Buffalo, and polycross progenies of Clones 1740, 240, and 242 still maintained satisfactory stands and were giving top yields.

Central Pennsylvania: In this series of plots, Narragansett continued to be a top-yielding variety. Wisconsin Synthetic-G continued to give good performance as did Atlantic and Buffalo. Ranger gave satisfactory yields but was down somewhat from the top-yielding variety. Polycross progenies of Clones 240 and 242 were high in yields at this location.

B. 1950 Alfalfa Observation Nursery: Since stands had not deteriorated in this planting, no yield data were taken during 1952. However a series of foliage disease observations were taken July 7. Polycross progeny of Clones 1569A, 1573F, 1585B, 2173, 2240, and the variety DuPuits were outstanding at this date for resistance to leafspot diseases.

C. 1951 Planting: At every location Narragansett was the top-yielding variety in this first harvest year of the test. Yields of Talent were generally lower than the average from the tests and yields of Rhizoma were satisfactory but lower than the top-yielding variety. On the basis of the results that have been obtained during the past four years it seems fairly logical to make the suggestion of not taking yield data for the first one or two years of a trial. Differences are usually small and not significant during the first and sometimes even the second year of harvest. Data might be accumulated during this period on such factors as disease resistance and possibly insect resistance. The critical period in stands usually arises during the second and third harvest years. Following such a practice might enable the plant breeder to test considerably more material and to devote greater efforts to observational notes on characteristics other than yield.

Title: THE GENETICS AND IMPROVEMENT OF FORAGE GRASSES

Leader: H. R. Fortmann

Primary emphasis in this project continued to be devoted to orchardgrass, bromegrass, timothy, and reed canarygrass.

Orchardgrass: Evaluation of clones selected at the Pasture Laboratory has been continued during the past year. In addition the restricted polycross progenies of the Pasture Laboratory's synthetic clones were continued. Seed of 150 superior clones, established in polycross nurseries at State College, Pennsylvania, in 1951 was harvested during the 1952 season. There is a good supply of polycross seed of 113 of these clones. Small amounts of seed of the remaining 37 are available for testing. Additional data have been obtained on the variety yield trial established at five locations in Pennsylvania in the spring of 1949. The importance of differential cutting dates in order to obtain fair comparisons of the yielding ability of varieties differing in maturity dates has been emphasized during this past season's results. Yield data obtained at two of the locations, where the varieties were harvested at a comparable stage of maturity, have resulted in higher yields from the three late maturing varieties S-26, S-37, and S-143 than from early maturing varieties such as Avon, Minnesota 2905, and Maryland Hay Strain. However when these varieties were all harvested at the same date, in other words at unlike stages of maturity, the early maturing varieties out-yielded the late maturing ones by a considerable margin.

Bromegrass: Evaluation of selected bromegrass clones by means of their polycross progenies continued during the past season. A marked varieties x locations interaction was obtained with the bromegrass varieties established in the spring of 1949. In the center and in the southeastern portions of the state, the southern-type varieties, exemplified by Lincoln, Achenbach, and Fischer, continued to be top-yielding. However in the two western test areas of the state, the intermediate varieties, particularly Manchar and Bromus inermis 12 from Utah, out-yielded the southern ecotype varieties by a significant margin. This differential

performance of the varieties is one which began to develop in 1951 and was accentuated during the 1952 season. The decline in yield of southern ecotype varieties is obviously the result of diseases that are affecting them more seriously than the intermediate varieties. It is hoped that during the coming season conditions will permit investigation of the specific diseases and causal organisms that are affecting the bromegrass varieties in the western areas of the state.

Timothy: Yields were obtained again on the space planted source nursery consisting of polycross progenies of clones selected at Purdue University. The variety yield trials were continued with timothy but the differences were not particularly great considering the average of all locations.

Reed Canarygrass: At the present time reed canarygrass is a little used forage species in Pennsylvania. It is recommended for low, wet areas but the supply of available seed is small. However in the test trials, when adequately fertilized with nitrogen or grown in association with a good legume, it has been high yielding. One of the principal criticisms of the species is its lack of palatability for dairy animals. Attempts to discover variation in the relative palatability of polycross progenies of selected reed canarygrass clones during the fall of 1952 met with little success. Cattle were grazed on the aftermath production of reed canarygrass polycross progeny plots. In general, the livestock refused to eat the reed canarygrass until after they had removed virtually all of the vegetation from alleyways and borders, but they did eat reed canarygrass forage which had been removed from the plots and piled outside of the fence, even though it had been rained on two or three times and appeared relatively unpalatable. Differences in harshness, to the touch, were observed in the polycross progenies but there was apparently no correlation between this human evaluation and palatability as measured by the grazing livestock. June, July, and August were extremely hot and dry during 1952. Under these conditions reed canarygrass was much more productive and able to withstand the hot dry conditions better than any of the other forage grasses under test in the Agronomy Department trials. Work will be continued on this species but more information must be obtained on its palatability and the conditions influencing it before an extensive breeding program would be warranted.

Other Forage Grasses: Variety testing work with the fescues, both tall fescue and meadow fescue, with tall oatgrass, and with perennial ryegrass continued during the past season. There is considerable doubt as to the importance of these species in the Pennsylvania Forage Crops Program. Tall fescue varieties continued to out-yield those of meadow fescue. Perennial ryegrass does not appear to be adapted to Pennsylvania conditions. Tall oatgrass is a top-yielding species but seed is limited and little is known about its palatability and usefulness in a forage program. Of the tall oatgrass varieties tested, Tualatin would appear to be the best suited for Pennsylvania conditions.

Title: EVALUATING VARIOUS TALL GROWING GRASSES WITH DIFFERENT LEGUMES AND WITH NITROGEN FERTILIZER FOR PENNSYLVANIA

Leaders: J. B. Washko and R. P. Pennington

The percentage of legumes in the various legume-grass associations was lower in 1952 than in the previous two years of the experiment (1951 Annual Report, page 75). Of the three legumes, alfalfa, birdsfoot trefoil, and Ladino clover, which were grown in grass associations the Ladino clover stands were poorest the third year after establishment. With the disappearance of the legumes the level of hay production dropped from an average of 2.83 tons per acre for all legume-grass associations for the years 1950-51 to 2.10 tons in 1952.

As in 1951 highest forage yields were obtained when 100 pounds of nitrogen was applied to the grasses alone in the form of a split application of 60 and 40 pounds per acre in the early spring and after the first harvest, respectively. Reed canarygrass, orchardgrass, and tall oatgrass grown alone and fertilized with 100 pounds of nitrogen per acre were the highest yielding species in the order named in 1952. Reed canary grass produced the highest yield of dry matter per acre for two cuttings whether grown alone and fertilized with nitrogen or grown in legume combination; fertilized with nitrogen but grown alone it yielded 3.13 tons per acre whereas grown in association with alfalfa it yielded 2.46 tons.

Title: RENOVATION OF UNPRODUCTIVE PASTURES

Leaders: J. B. Washko and A. W. Clyde

Four experiments are now in progress under this project. Readings on sod kill were obtained in the spring of 1952 on the two experiments initiated in the late summer of 1951 (1951 Annual Report, page 78). The degree of sod kill obtained with the various tillage implements and TCA was as follows: TCA 100 per cent kill, moldboard plow, cutaway disk, disk plow, and field cultivator 90 to 98 per cent kill, and poorest kill, 75 to 80 per cent with the Graham-Hoeme plow. Irrespective of the method employed for eradication of the old sod in the fall all plots except those aerified were disked and spring-toothed in the spring, a proper seed bed was prepared, and seedings were made. Satisfactory stands of the various legumes and grasses were obtained with the spring seedings made in 1952 on all plots where the old sod had been killed. However on the check plots and in those on which the pasture aerifier was used seeding failure was experienced. Forage yield data on these two experiments will be obtained in 1953.

Two additional experiments were also initiated on this project in the late summer of 1952. Treatments for eradication of the old sod were modified somewhat from those used in 1951 to include two additional chemicals, CMU and IPC. Fertilizer and lime were applied in accordance with soil test analyses and seedings will be made in the spring of 1953.

Title: FORAGE AND GRAIN PRODUCTION OF WINTER SMALL GRAINS AS INFLUENCED BY FERTILIZATION AND MANAGEMENT PRACTICES

Leaders: J. B. Washko, R. P. Pennington, and A. L. Haskins

Experiments which were conducted in this study during the 1951-52 small grain growing season were similar to those carried out in 1950-51 (1951 Annual Report, pages 75-76). Clipping experiments were established in central and southeastern Pennsylvania to determine the influence of time and rate of nitrogen applications and time of forage removal on forage yields and subsequent grain production. A grazing experiment was established in central Pennsylvania to study time of nitrogen applications, time of forage removal, method of seeding (rows vs. cross drilled), and method of forage removal (clipping vs. grazing). One variety of wheat and one variety of barley were used in each of the 1951-52 experiments.

Three year's results show that:

1. Under favorable growing conditions small grains seeded 5 to 6 weeks prior to the regular seeding date produced up to 1 ton of dry forage per acre before the onset of winter.

2. Fall forage production was related directly to availability of moisture. With ample rainfall such as characterized the fall of 1949 forage production in central Pennsylvania averaged 1532 pounds of dry matter per acre; in 1950 with less rainfall yields were 844 pounds per acre; and in 1951, the season with less rainfall than either of the two previous seasons, only 243 pounds per acre of forage were obtained.

3. The crude protein content of small grain forage was exceptionally high in the fall, ranging as high as 35 per cent, but decreased as the season progressed to a low of approximately 20 per cent in spring forage harvests.

4. Small grains required large amounts of nitrogen to produce high yields of forage. One ton of fall forage contained approximately 100 pounds of nitrogen.

5. In some instances grain yields from plots clipped for forage in the fall were greater than from unclipped plots which produced grain only.

6. Under favorable growing conditions the T.D.N. value of forage alone from plots clipped in both the fall and spring approached that of the grain from unclipped plots.

7. The removal of forage in the spring whether or not preceded by fall forage removal was especially deleterious to subsequent grain yields.

8. In several instances the application of nitrogen in the early spring significantly increased spring forage production and subsequent grain yields.

9. In most instances decreases in grain yield resulting from clipping were compensated for by the feeding value of the forage removed.

10. The action of grazing cattle as a means of removing forage was no more harmful to grain yields than removing the forage by clipping.

Title: EFFECTS OF DIFFERENT STUBBLE MANAGEMENT PRACTICES ON MAINTENANCE OF RED CLOVER

Leader: J. B. Washko

The experimental procedure followed in this experiment for 1952 was essentially the same as reported in 1951 (1951 Annual Report, pages 74-75). The data obtained from these experiments to date indicate that: (1) straw left in windrows by the combine smothers out the clover and hence yields are reduced the following year; (2) straw left by the combine should either be removed or scattered if red clover stands are to be preserved; (3) straw stubble should be cut and removed during the period of August 15 to September 15 in the seeding year if maximum yields of hay are to be obtained the following year; (4) clipping stubble as late as October 1 is harmful to maintenance of red clover stands and hay yields; and (5) late clipping of stubble is more harmful when the clipped stubble is allowed to remain on the plots over winter.

Title: SEED AND FORAGE PRODUCTION OF FIVE GRASS SPECIES AS AFFECTED BY NITROGEN FERTILIZATION AND METHODS AND RATES OF SEEDING

Leader: R. E. Buller

This investigation was concerned with phases of seed production of four perennial grasses: orchardgrass, bromegrass, timothy, and reed canary-grass and with Sudan grass. Factors in the study were rates of planting, broadcast versus row planting, and time and rate of nitrogen application. In general the results indicated that row plantings at a light seeding rate gave the highest seed yields. An application of 50 pounds of nitrogen per acre applied in the early spring gave yields that were not significantly exceeded by other times and rates of application.

Title: YIELDS OF VARIOUS FORAGE SPECIES UNDER IRRIGATION

Leaders: R. B. Alderfer and J. B. Washko

Supplemental irrigation was applied to various legumes and legume-grass combinations in 1952 when the moisture level at a depth of 5 inches dropped to (1) the wilting point and to (2) 1/2 field capacity. Check plots which received only natural rainfall were also included as part of this experiment (1951 Annual Report, pages 76-77).

Irrigation was begun on June 12 and the last applied August 29. A total of 4.10 acre inches of water in three applications was applied to the plots simulating pasture conditions at level (1) and 7.9 acre inches was applied at level (2). On the plots managed for hay 2.80 acre inches were applied in two irrigations at moisture level (1) and 3.30 acre inches in five irrigations at moisture level (2). An additional treatment, 80 pounds of nitrogen per acre, on the orchard-Ladino and Kentucky bluegrass-white clover was applied in 1952 as a split application of 40 pounds each after the second and fourth harvests, respectively. As indicated in Table 4 forage production was increased considerably by irrigation particularly at the higher moisture level. Greater increases were obtained from irrigation on the "pasture species" than on the "hay species".

The use of nitrogen on the pasture species further stimulated forage production and when both nitrogen and irrigation were combined highest forage yields were obtained. As in 1951 the yield differences obtained under the two fertility levels used in this experiment, namely 400 and 800 pounds per acre of a 0-20-20 fertilizer were minor.

Table 4. Yields of forage under different irrigation treatments July 14 to September 10, 1952.

Species	Dry Matter Productions - Tons/Acre					
	Moisture Levels					
	Without Nitrogen			With Nitrogen		
	Check	Wilting Point	1/2 Field Capacity	Check	Wilting Point	1/2 Field Capacity
Ky. blue-white clover	.09	.16	.34	.28	.62	.83
Orchard-Ladino clover	.43	.49	.91	.65	1.16	1.49
Brome-alfalfa	1.44	1.80	1.98	---	---	---
Alfalfa	1.44	1.84	2.04	---	---	---

Title: EVALUATION OF GRASSES AND LEGUMES FOR POULTRY PASTURE

Leaders: P. H. Margolf, M. G. McCartney, J. B. Washko, R. P. Pennington, and A. L. Haskins (in cooperation with V. G. Sprague of the Pasture Research Laboratory)

Orchardgrass for turkey pastures under two systems of grazing management differing in intensity: Pasturing began May 20 for the eighth successive year (1951 Annual Report, page 17). Two areas were grazed rotationally, about three weeks being required for a rotation. All equipment--shelters, feeders, and waterers--were moved daily. The poults were fed a 20 per cent protein turkey growing mash mixture, whole oats, whole wheat, whole corn, and calcium grit in outdoor hoppers. The poults were sexed when taken to range and 235 male and 210 female poults placed on the heavy and on light grazing areas, respectively. An additional 80 male and

75 female poults were reared in confinement and fed a similar ration except 2 per cent of a 6000A fish oil was added to the mash mixture. The results are given in Table 5.

Table 5. Average body weights, pounds of turkey produced per acre, yield of orchardgrass (dry weight) per acre, and protein content of the grass.

	Average Body Weight	Pounds Turkey Produced Per Acre	Orchardgrass	
			Yield Dry Matter Per Acre	Protein Content
	pounds	pounds	pounds	per cent
Males grazing	22.2	2081.7	3860	24.4
Females grazing	12.2	1119.7	3780	23.4
Males confinement	21.5			
Females confinement	11.9			

As in past years, intensity of grazing influenced both forage yields and protein content of the orchardgrass but to a less marked degree. Undoubtedly the drought masked the differences apparent in other years.

Carrying capacity of grasses and legumes for turkeys on pasture and growth responses of turkeys on supplementary feed of different protein levels: Grazing trials with turkey poults were continued in 1952 on the replicate areas known as I, II, and III, each consisting of five one-acre plots. Four grasses--orchard, brome, reed canary, and Kentucky blue--and Ladino clover provided the coverage for the three replicate areas. Eighteen hundred White Holland turkey poults were brooded and fed The Pennsylvania State College 25 per cent starter mash until they were 8 weeks of age; then they were given the 20 per cent protein developer mash. All poults at 10 weeks of age were moved to range and 110 poults placed on each one-acre area. On June 24, when the poults were 15 weeks old, poults on Area I continued on the 20 per cent level; mash mixtures of 11 and 16 per cent protein were fed to the poults on replications II and III, respectively. In addition, whole corn, wheat, oats, and calcite grit were fed in separate hoppers. All areas were grazed rotationally and the management was similar to that described above. The weights of birds are given in Table 6.

These are average yields for the season and are misleading since the effects of the severe 1952 drought are masked. During the three months of July, August, and September, forage production was very low, from 60 pounds of dry matter per acre to a high of only 320 pounds per acre for the grasses. One of the Ladino clover ranges was watered with a garden sprinkler during a major portion of the drought period to assure the birds on a low protein diet of an ample supply of a high protein forage. The average production of dry matter on the irrigated Ladino range over the three-month drought averaged 960 pounds of dry matter to 300 pounds and less for the nonirrigated.

The average protein content of these various species for the season, though considerably higher than in 1951, was as follows: Ladino clover, 25.7; reed canarygrass, 23.4; bromegrass, 23.2; Kentucky bluegrass, 22.3; and orchardgrass, 21.7. During the drought period the irrigated Ladino clover averaged 3 to 4 per cent higher in protein than the nonirrigated.

Table 6. Average body weights of males and females.

Replication and mash protein level	Brome	Kentucky Blue	Orchard	Reed Canary	Ladino Clover
	pounds	pounds	pounds	pounds	pounds
MALES					
I - 20 per cent	22.2	23.2	23.1	22.5	23.3
II - 11 per cent	22.0	21.7	22.8	21.4	22.6
III - 16 per cent	22.2	22.1	22.4	22.3	22.4
FEMALES					
I - 20 per cent	12.0	12.6	12.5	12.6	12.3
II - 11 per cent	12.4	12.5	12.3	12.0	12.5
III - 16 per cent	13.0	11.7	12.2	11.9	12.0
Amount of forage available in dry matter per acre	1943	1680	2376	2230	2640

Title: MEASUREMENT OF THE NUTRITIVE VALUE OF PASTURES AND PASTURE PLANTS

Leaders: R. L. Cowan, R. W. Swift, and J. B. Washko

Previously reported work (1949 Annual Report, page 26; 1950 Annual Report, page 19; and 1951 Annual Report, page 14) has established the relative nutritive value of several specific individual forages. In the light of common knowledge concerning associative effects of feedstuffs, it was suspected that the nutritive values of the individual forages might not be applicable to mixtures of the same forages.

During 1951-52, a single sample of first cutting alfalfa harvested June 11, 1951, was fed to sheep in combination with:

(1) timothy cut June 12
(2) timothy harvested at a very mature stage (cut July 9)
(3) orchardgrass at a silage stage (cut May 23)
(4) orchardgrass at a grazing stage (second cutting - June 16)

Combinations (1) and (3) were fed in both 1:1 and 1:3 ratios. Digestible energy, metabolizable energy, and T.D.N. values were determined on the

mixtures. These values were compared with corresponding values obtained by calculation on the basis of the digestion coefficients and nutritive values of the individual forages. In the case of the timothy-alfalfa combination, the determined values were generally higher than the calculated values, indicating a supplemental effect of combining these two forages. Orchardgrass-alfalfa combinations exhibited a lesser associative effect and in the opposite direction; i.e., the determined values were generally lower than the calculated values, indicating a slightly antagonistic effect of combining these two crops. In both the orchardgrass-alfalfa and the timothy-alfalfa mixtures the associative effect was considerably more pronounced in the 3:1 than in the 1:1 combinations.

Title: SODIUM METABISULFITE AS A PRESERVATIVE FOR GRASS SILAGE

Leaders: R. L. Cowan, J. W. Bratzler, and R. W. Swift

Experiments were conducted on the use of a concentrated water solution of sodium metabisulfite as a preservative for grass silage. Various grasses and legumes were ensiled in 1-gallon glass jars fitted with rubber stoppers and with water traps arranged to allow seepage and escape of gases and to exclude air. The silages preserved with metabisulfite kept as well as comparable materials treated with sulfur dioxide gas at equivalent levels and better than untreated control samples. In addition a small silo (3 x 8 feet) was filled with third-cutting alfalfa to which sodium metabisulfite was added at a rate of 8 pounds per ton. At the end of 3 months an excellent quality silage was eaten with relish by sheep over a period of more than a month at a rate of about 8 pounds per day per 100 pounds live weight. Work is planned to investigate the use of metabisulfite in powder form under different conditions.

Title: FORAGE INSECT INVESTIGATIONS

Leaders: N. D. Blackburn and Finley B. Negley

Experimental studies on forage insects conducted during the 1952 season were designed to secure additional data on the relative effectiveness of various insecticides applied at different times during the spring for control of the meadow spittlebug and root borer on red clover.

Materials applied specifically for control of the spittlebug included lindane, dieldrin, toxaphene, and methoxychlor in the form of emulsifiable concentrates and aldrin and chlordane as wettable powders in replicated plot experiments.

Lindane, methoxychlor, and dieldrin applied on April 26, when approximately 50 per cent of the eggs had hatched, were most effective, while in the second series of applications made one week later, lindane, methoxychlor,

and toxaphene were superior. Aldrin and chlordane were the least effective of the materials tested. Data taken at harvest showed significant increases in first-cutting hay yields (dry weight) of approximately 25 per cent for the superior insecticides.

Population levels of immature spittlebugs appeared to be somewhat lower than during the preceding season. Records taken during the spring indicated that approximately 25 per cent of the eggs failed to hatch. This was attributed to the cold weather occurring on April 24-27 after the embryos had reached a late stage of development.

Records taken in August from plots sprayed with chlordane, gamma benzene-hexachloride, and dieldrin at the rate of 5.0, 1.25, and 0.8 pounds per acre, respectively, for control of the clover root borer showed that applications of all materials made on May 10 were more effective in reducing root-infesting populations than those made at any of the three preceding weekly intervals.

Data on residue levels on the hay at harvest were inconclusive. Analyses by different agencies indicated too large a variation to be attributed to sampling alone.

RHODE ISLAND

Title: BREEDING IMPROVED ALFALFA FOR THE EASTERN UNITED STATES

Leaders: T. E. Odland and C. R. Skogley

The objective in the present alfalfa breeding program is to incorporate bacterial wilt resistance in the Narragansett variety. Six years of crossing have failed to produce satisfactory results. A new approach to the problem is proposed for the future and the work will be continued. Close attention is also paid to the selection of improved plants from the standpoint of leaf and stem diseases.

The production of Breeder seed of the Narragansett alfalfa variety has progressed favorably. Better than 53 pounds of seed was produced in 1952 and will go into the Foundation Seed Program for the production of Foundation seed. Thirty to forty thousand pounds of Certified Narragansett seed may be released in the Northeast for 1953. Two more favorable years should see adequate supplies of seed on the market.

Two uniform alfalfa nurseries were planted during the past year. Three cuttings were taken from the nursery planted in the fall of 1951 and two cuttings were obtained from the nursery planted in the spring of 1952. Of the named varieties in both nurseries, Narragansett, DuPuits, and Atlantic have been outstanding. Ranger has also performed well.

Title: SOIL FERTILITY AND SOIL MOISTURE RELATIONS IN GRASSLANDS OF THE NORTHEAST

Leaders: Donald A. Schallock, Irene H. Stuckey, Milton Salomon, and Robert Beverage

A Ladino clover-bromegrass stand gave excellent response to varying levels of P_2O_5 and K_2O on the experimental area initially low in fertility and no response during this second year on the area with moderate fertility levels. See Table 7.

Soil and plant samples are being analyzed for potassium to determine relationships between plant feeding and fixation and loss of potassium in the soil.

Table 7. Response of Ladino clover and bromegrass to various fertility treatments.

	Annual Treatments Pounds per acre		1952 Yield Tons per acre (oven dry)
	P_2O_5	K_2O	
1.	0	0	1.2
2.	0	240	1.5
3.	30	240	2.7
4.	60	240	3.8
5.	120	240	3.1
6.	120	0	1.9
7.	120	30	2.5
8.	120	60	3.0
9.	120	120	2.9
10.*	120 (top dressing)	240	2.5
11.*	120 (worked into soil)	240	2.5
12.*	120 (in bands)	240	2.8
13.	240	240	3.8
14.	120 (plus 2.5 lbs. boron)	240	4.4

* In treatments 10, 11, and 12, P_2O_5 was added only in the first year.

Title: POTASH SOURCES AND RATIOS

Leaders: Donald A. Shallock and T. E. Odland

A study of potash sources and amounts of K_2O in relation to P_2O_5 was begun last year. First cutting yields of as much as 15 tons per acre of field silage weight, or 2.82 tons per acre dry weight, were obtained at levels of 80 pounds of P_2O_5 and 160 pounds of K_2O. Yields of 10 tons per acre field weight, or 2.1 tons dry weight, were obtained where 80 pounds P_2O_5 and 40 pounds K_2O were applied. There were no differences between yields on the sulfate and muriate sources of potassium.

VERMONT

Title: CYTOGENETICS AND BREEDING INVESTIGATIONS WITH FORAGE LEGUMES

Leaders: A. Gershoy and Glen Wood

Polyploid Ladino Clover, T. repens var. latum 4n = 64: Seed increase, designed for regional plot and farm trials and not consummated in 1952, will be again attempted in 1953, with the cooperation of Dr. H. H. Rampton et al. of the Oregon Agricultural Experiment Station. Comparative plot trials of the polyploid strain, alone and in bromegrass and orchardgrass association, gave appreciably lower yields in the first harvest year in the dry 1952 growing season, than found in 1951 in a wet season. In 1952 both the Oregon certified and Aberdeed Idaho Breeder's strains were significantly superior to the Vermont polyploid strain. But in both sets of trials the polyploid strain showed a tendency to give higher yields in the cuts during the higher temperatures, in June, July, and August than in the May cut. There is an indication that this strain may be better adapted to management under irrigation, high fertility levels, and higher temperatures than under average farm conditions in the Northeast. The trials will be continued.

Broadleaf Birdsfoot Trefoil, Lotus corniculatus: The Vermont synthetic strain, which is essentially an European hay type, produced a creditable seed crop in July and another seed crop in late fall. The 1952 growing season was sufficiently long and favorable. Recovery growth was found to be vigorous on both undrained Panton clay and on the better drained Vergennes clay. A table of comparison yields with other strains of broadleaf is presented here. The Vermont strain should be tested in the NE-10 Regional trials.

Vermont 1, a synthetic strain of birdsfoot trefoil, was superior in yields to Viking II, Granger, and Empire in the first harvest year when managed for silage. These strains are being tested alone and in combination with timothy and late Finnish type orchardgrass on two soil types. Because of the dry season only two cuts were obtained. The Burlington data represent the average of four and the Addison data of two replications. A summary of the yield data is in Table 8.

Polyploid Narrowleaf Birdsfoot Trefoil, L. tenuis 4n = 24: Selection in maternal lines is being continued. Vigorous plants, showing pasture-type characteristics and good recovery growth after cutting, have appeared in several lines. From field observations it seems not unlikely that groups of more fertile individuals may be obtained. Observations of field plots, in the seedling year, indicate more vigorous first season's growth, than in commercial diploid strains.

Table 8. Trefoil strain trials - 1952.

Dry weight yields of trefoil fraction in tons per acre

	Addison Panton Clay Cuts			Burlington Vergennes Clay Cuts			Total
	First	Second	Average	First	Second	Average	Average
Vermont I	.71	.61	.66	.66	.55	.61	.63
Viking II	.80	.67	.74	.51	.29	.40	.57
Granger	.58	.79	.69	.36	.25	.31	.50
Empire	.67	.65	.66	.45	.19	.32	.49
Vt. I - Timothy	.70	.79	.75	.46	.45	.46	.60
Vik. II - Timothy	.53	.59	.56	.42	.29	.36	.46
Granger - Timothy	.49	.62	.56	.36	.37	.37	.46
Empire - Timothy	.68	.49	.59	.18	.08	.13	.36
Vt. I - Late Orch.	.71	.54	.63	.55	.32	.44	.53
Vik. II - Late Orch.	.63	.40	.52	.41	.20	.31	.41
Granger - Late Orch.	.33	.47	.40	.30	.24	.27	.34
Empire - Late Orch.	.61	.35	.48	.23	.08	.16	.32

Average All Plots

Vermont I	.59
Viking II	.48
Granger	.43
Empire	.39

Title: DATE OF SEEDING LEGUMES, GRASSES, AND WEEDS

Leaders: K. E. Varney and A. R. Midgley (in cooperation with V. G. Sprague of the Pasture Research Laboratory)

Seedings of major legumes, grasses, and weeds were made on five dates--November, December, March, April, and May. The November, April, and May plantings were made on prepared land and were covered from 1/4 inch to 1/2 inch deep. December and March seedings were made on frozen ground.

As in the past, (1951 Annual Report, page 20) both grasses and legumes responded best to spring planting although grasses showed a much greater tolerance to fall planting (based on stand) than did the legumes.

March plantings of legumes (frozen ground) were much superior in stand to plantings made in November (covered) or December (frozen ground). Weeds again grouped into two categories, those doing best when planted in the fall or on frozen ground and those responding best to spring plantings.

On August 15 stand counts were made and yields of individual plants determined. The results are shown in Table 9.

Table 9. Relationship of relative per cent stand and relative weight per plant to date of seeding. (Based on April seeding = 100)

Date of Seeding	Grasses		Legumes	
	Stand	Weight	Stand	Weight
November 15	55	318	21	595
December 15	73	216	26	279
March 15	75	118	66	174
April 15	100	100	100	100
May 15	115	36	101	83

WEST VIRGINIA

Title: FORAGE CROPS VARIETIES, STRAINS, AND SPECIES FOR WEST VIRGINIA

Leaders: O. J. Burger, S. L. Galpin, D. A. Ray, C. Sperow, and Robert L. Bond

Yield studies (reported in tons at 12 per cent moisture level) were made on birdsfoot trefoil, red clover, and alfalfa grown alone and with orchardgrass, bromegrass, and timothy. Ladino clover for the most part had winterkilled, but by the last of August had recovered to a limited extent. The grasses were also grown alone and in association with the above-mentioned legumes. Management treatments were silage and aftermath, pasture and hay. Total yield of the mixtures as well as yield contribution of species in the mixtures was studied.

In the study of legume species the highest yielding mixture was alfalfa-bromegrass. This was the outstanding mixture. The superior alfalfa varieties involved were Narragansett and Williamsburg. Other outstanding legume-grass combinations were Ladino clover-orchardgrass and birdsfoot trefoil-timothy.

Significant yield differences were found in the case of the grass species study. Nitrogen was applied to the grass-alone plots after each cutting. This treatment was responsible for the high yield increase over any of the plots where a legume was associated with the grass.

Significant difference due to management was found only in the case of Ladino clover where the silage-managed plots out-yielded those managed for pasture. The varieties and strains of both the legume and grass species performed about the same regardless of the species associated with them.

The outstanding legume varieties were Italian and Viking birdsfoot trefoil, Breeder's Kenland red clover, and Narragansett alfalfa. The commercial orchardgrass, Lincoln and Achenbach bromegrass, and commercial timothy were the highest yielding grass varieties.

Bromegrass adaptation plots were seeded at 8 locations in West Virginia. These plots were so located that most of the varied conditions of the State would be represented. Six of these seedings were successful and there are good stands of the 11 varieties of bromegrass and Beltsville orchardgrass that are being studied. Two strains, Oklahoma synthetic and Oklahoma No. 1, were superior in nearly all locations. They are very leafy and have a good recovery rate after cutting. Lincoln, Achenbach, and Elsberry, as well as Fischer, performed very well. All these brome plots were managed for hay. This coming season two plots also will be managed for pasture. Northern variegated alfalfa is the legume growing with these bromegrass varieties.

In the advanced alfalfa nursery seeded in 1951, Narragansett out-yielded all other 24 entries. The entries 07-2190 and 07-2239 had a distinctly greener color than the others.

An Atlantic alfalfa group seed-source plot was seeded May 1, 1952. No yield data are available but full season data will be taken during the 1953 season. Additional Synthetic bromegrass plots, birdsfoot trefoil clones, and orchardgrasses of varying maturity plots were also seeded May 1.

The seeding of seventy-five clonal lines and six alfalfa checks in 1951 was a failure. No attempt will be made to reseed.

Material available from the NE-10 project was adapted to serve as a more complete study of Narragansett, Williamsburg, and Grimm alfalfa. Two methods of estimating botanical composition--(1) field estimation of the standing forage, and (2) estimation of dry matter sample, were compared with the hand separation determination. The greater accuracy and comparative speed for the dry sample estimation method indicates that it should be put to greater use.

There was no difference in carotene content per unit of dry matter of leaf material in the three varieties. Carotene content was negatively correlated with alfalfa leaf yields and positively correlated with total cation content of alfalfa leaves. The mineral content of the grass and weed component was negatively correlated with the same mineral element content of the corresponding alfalfa component.

The effects of various soil factors on growth and mineral content of various species in mixtures were observed. Organic matter and sodium content of the soils were positively correlated with total yield of all separates. Yield of the alfalfa separate was negatively correlated with pH, organic matter, soil calcium, and total bases under the conditions of high calcium and high pH (6.1 - 7.4), but was positively correlated with soil potassium and magnesium. Positive correlations existed between potassium, sodium, calcium, and total cation content of the alfalfa separates and the respective element content in the soil. Grimm

showed positive correlations between the alfalfa content and soil content of calcium, potassium, and total bases. Potassium content of Narragansett was positively correlated with soil potassium, and Williamsburg showed a positive correlation between plant and soil sodium. These data give some evidence that physiological differences exist between alfalfa varieties within the limits of the observed factors of this experiment.

Title: THE ESTABLISHMENT AND TESTING OF GRASS AND LEGUME SPECIES AND STRAINS FOR SOIL CONSERVATION

Leaders: O. J. Burger and Frank Glover, Jr.

Narrowleaf birdsfoot trefoil, broadleaf birdsfoot trefoil, and Rhizoma alfalfa were grown alone and with Beltsville orchardgrass, Lincoln bromegrass, commercial timothy, commercial Kentucky bluegrass, and Kentucky 31 fescue, in plots established on June 12, 1951. The grasses were also seeded alone. All plots were managed for pasture and three clippings were made. The Rhizoma alfalfa and mixtures thereof out-yielded all the other species. Broadleaf birdsfoot trefoil yielded more than 3 tons dry matter and this yield came at a very uniform rate during the season, with about one ton per cutting. The broadleaf birdsfoot trefoil plots, whether they were growing alone or with the grasses, out-yielded the narrowleaf trefoil. The broadleaf trefoil growing alone yielded as much as the mixtures in which it was included.

Observations on seven tall fescue plantings indicate that the stands of fescue were better in 1952 than during the season they were seeded. There is not enough Ladino clover in those stands. Under continuous grazing, fescue appeared to be making more growth than any other species during the midsummer period of high temperatures and low rainfall. The fescue is studied to determine the adaptation and superiority of Kentucky 31 fescue for forage and soil protection under a wide variety of soil and climatic conditions in West Virginia.

In a strip mine spoil revegetation field trial alfalfa, sweet clover, birdsfoot trefoil, alsike clover, Korean lespedeza, sericea, and Rush lespedeza as well as weeping lovegrass, tall fescue, redtop, switch-grass, and orchardgrass were seeded. In general seedlings were small for all species. Appearance of the plots indicated that moisture was a limiting factor. Seeding should have been done approximately 30 days earlier.

Work on methods of establishing birdsfoot trefoil was continued. Methods of inoculation, fertilization, seed treatment, seeding practices, and grass associations are being studied. Birdsfoot trefoil is being studied as a hay and pasture plant. Trial plantings were made at 3 locations in 1951 and 3 locations in 1952. The latter were planted for pasture.

Narrowleaf and European trefoils germinate and emerge before Empire. Narrowleaf looks particularly good the first season in comparison to the others. Narrowleaf flowers more profusely and has most seed

remaining after clipping. European has the least seed remaining after clipping. There was much competition from native grasses and weeds on sites which were disked. A complete fertilizer including 15 pounds of nitrogen was used at time of seeding. There have been numerous failures to get proper inoculation. Seed sown at one of the Experimental Farms was inoculated with commercial inoculant and another area was seeded with seed treated with soil from established birdsfoot plants.

In the stone fruit orchard cover trial, crimson clover, button clover, meadow foxtail, and field bromegrass were seeded. Crimson clover provided the best cover of the four species. None, however, set enough mature seed to get any reseeding after the orchard was cultivated.

Kudzu plantings were made at four locations in 1952. There was about 60 per cent survival. These plantings will be studied during 1953 for winter hardiness, ability to control erosion, and possibility for use as mid-summer pasture.

In the trial involving the utilization and management of sericea lespedeza a good stand was obtained on a three acre trial planting at one location in 1952. Possibility of using sericea as pasture will be studied in 1953.

Title: THE INFLUENCE OF FERTILITY AND MANAGEMENT ON SEVERAL LADINO CLOVER-GRASS MIXTURES

Leaders: O. J. Burger, C. Sperow, and D. R. Browning

Ladino clover and various grasses were seeded in the spring of 1951. Ladino clover was seeded alone and in combination with Kentucky 31 fescue, Lincoln bromegrass, Beltsville orchardgrass, and reed canarygrass. Four fertility levels were applied in March 1952. These were: check, 800 pounds 0-10-0, 800 pounds 0-10-10, and 800 pounds 5-10-10. Three management treatments were imposed on all mixtures and fertility levels to simulate pasture cut, intermediate cut, and hay cut.

The pasture treatment produced the highest season yield. Within the hay management, the orchardgrass-Ladino clover association produced the highest yield with Kentucky 31 fescue and reed canarygrass following in that order. In the intermediate cut Kentucky 31 fescue out-yielded all the other mixtures while reed canarygrass-Ladino clover was superior under pasture management.

The greatest total yield was obtained when 800 pounds of 5-10-10 was applied. This, however, was not contributory to the highest yields of the Ladino clover component. The treatments which apparently increased the yield and stand of Ladino clover to the greatest extent were the 800 pounds of 0-10-0 and 0-10-10.

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